In cooperation with the U.S. Environmental Protection Agency

Sources of Polychlorinated Biphenyls to Devil's Swamp Lake Near Baton Rouge, Louisiana

Scientific Investigations Report 2006–5301

U.S. Department of the Interior
U.S. Geological Survey

212388

Cover

Top left: Sign near wastewater drainage ditch that enters Devil's Swamp Lake (October 2004).
Top right: Capping gravity core collected from Devil's Swamp Lake (October 2004).
Bottom: Portable watercraft on Devil's Swamp Lake (October 2004).

Sources of Polychlorinated Biphenyls to Devil’s Swamp Lake Near Baton Rouge, Louisiana

By Peter C. Van Metre, Jennifer T. Wilson, and Briant A. Kimball

In cooperation with the U.S. Environmental Protection Agency

Scientific Investigations Report 2006–5301

U.S. Department of the Interior
U.S. Geological Survey

U.S. Department of the Interior
DIRK KEMPTHORNE, Secretary

U.S. Geological Survey
Mark D. Myers, Director

U.S. Geological Survey, Reston, Virginia: 2006
For sale by U.S. Geological Survey, Information Services
Box 25286, Denver Federal Center
Denver, CO 80225

For more information about the USGS and its products:
Telephone: 1-888-ASK-USGS
World Wide Web: http://www.usgs.gov/

Suggested citation:

Van Metre, P.C., Wilson, J.T., and Kimball, B.A., 2006, Sources of polychlorinated biphenyls to Devil's Swamp Lake near Baton Rouge, Louisiana: U.S. Geological Survey Scientific Investigations Report 2006–5301, 50 p.

Contents

Figures

Tables

Sources of Polychlorinated Biphenyls to Devil's Swamp Lake Near Baton Rouge, Louisiana

By Peter C. Van Metre, Jennifer T. Wilson, and Briant A. Kimball

Abstract

Devil's Swamp Lake near Baton Rouge, Louisiana, created in 1973 by dredging in Devil's Swamp along the Mississippi River, is contaminated with polychlorinated biphenyls (PCBs) from historical industrial discharges. This study involved the investigation of the occurrence, distribution, and sources of PCBs in the lake, including the possible historical contribution of PCBs from a hazardous-chemical disposal facility by way of a wastewater drainage ditch that was used from 1971 to 1993. Six bed sediment cores from the lake and three bed sediment grab samples from the drainage ditch were collected; 61 subsamples from selected intervals in five of the six cores and the three grab samples from the ditch were analyzed for PCBs using an immunoassay screening method. Sixteen of the core subsamples and one ditch sample were analyzed for organochlorine pesticides, PCBs, polycyclic aromatic hydrocarbons (PAHs) (15 samples), and major and trace elements. PCB congener profiles and a factor analysis of congener composition indicate that PCBs in sediment from the drainage ditch and in lake sediment deposited near the canal since the mid-1980s are similar, which indicates the disposal facility, by way of the wastewater drainage ditch, is the source of the PCBs. Sediment from several hundred meters down the lake to the west, near where Bayou Baton Rouge enters the lake, had a different PCB composition and in a sample deposited in the early 1980s, a much higher concentration, indicating a second source of PCBs in the watershed of Bayou Baton Rouge. Large differences in PAHs and metals between sediment near the ditch and sediment near Bayou Baton Rouge support this conclusion. The identity of the Bayou Baton Rouge source(s) cannot be established using available data. The short duration and relatively high concentrations of PCBs from the bayou source indicate either a spill or a flood-related release—there was a large flood on the Mississippi River in 1983. Older (deeper) samples from cores near the drainage ditch (dated as deposited before the mid-1980s) had PCB compositions that indicate a mixture of sources (Bayou Baton Rouge and the drainage ditch). Elevated PCB concentrations in sediment from the drainage ditch and cores from near the mouth of the ditch in recent (post-2000) samples indicate that some PCB inputs from the ditch might still be occurring.

Introduction

Polychlorinated biphenyls (PCBs) were first synthesized in the laboratory in 1929, and an estimated 6.8 x 10^8 kilograms were produced in the United States prior to cessation of production in 1977 (U.S. Environmental Protection Agency, 2006). PCBs were used in hundreds of commercial and industrial applications, including as plasticizers, as hydraulic lubricants in gas turbines and vacuum pumps, in heat-transfer systems, and as dielectric fluids in electrical transformers. PCBs are, in general, highly resistant to chemical or biological transformation. Because PCBs are persistent in the environment and strongly hydrophobic, sediment deposited in lakes and reservoirs can provide a historical record of PCB contamination in the watershed. Sediment cores have been used to reconstruct water-quality histories in a variety of hydrologic and land-use settings (Davis, 1980). PCBs pose a threat to biota in aquatic systems because they are persistent, bioaccumulative, and toxic (U.S. Environmental Protection Agency, 1997).

Devil's Swamp Lake is on the north side of Baton Rouge, La., along the east bank of the Mississippi River (fig. 1). The lake was constructed by dredging in 1973, and the material removed was used to reinforce the levee along the north and west sides of the Baton Rouge Harbor (U.S. Environmental Protection Agency, 2004a). During flooding, the lake and surrounding swamp are inundated by water from the Mississippi River. A hazardous-chemical disposal facility is northeast of the lake. The facility began operating in 1971 and discharged wastewater to the north end of Devil's Swamp Lake through a ditch. Presumably, discharges during 1971–73 were to the area of the wetland that was dredged to form the upper (east) end of the lake. The wastewater drainage ditch remained in use until 1993 when a discharge pipe to the Mississippi River was installed and permitted. Runoff from the facility also entered Devil's Swamp upstream from the lake through one or more natural drainage areas (U.S. Environmental Protection Agency,

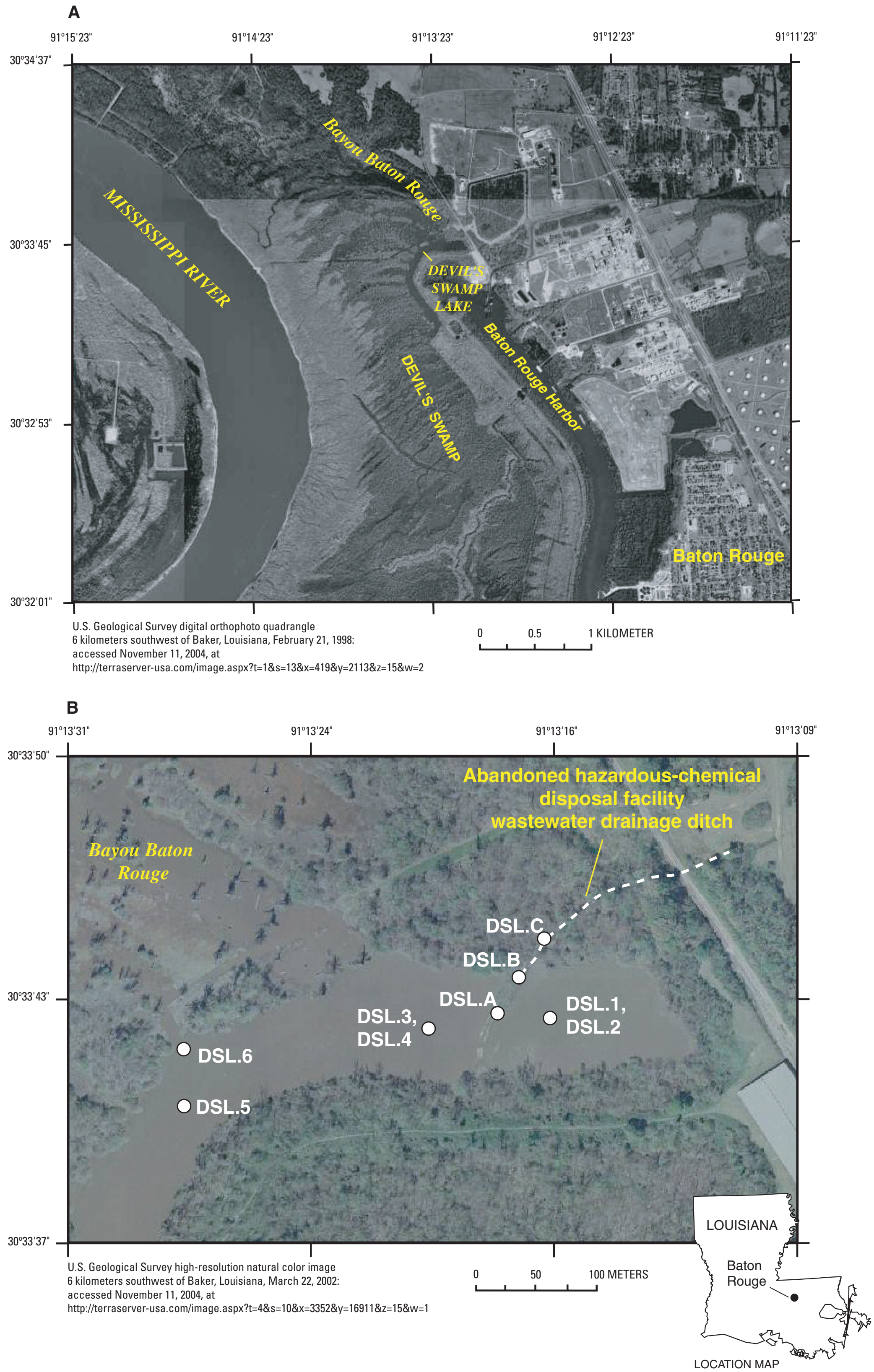


Figure 1. Aerial images of Devil's Swamp Lake near Baton Rouge, Louisiana, showing (A) lake in relation to surrounding features and (B) approximate locations of sites sampled October 5, 2004.

2004b). Sediment sampling done by the Louisiana Department of Environmental Quality and the U.S. Environmental Protection Agency in 1986 yielded PCBs in Devil's Swamp Lake and in the wastewater drainage ditch (U.S. Environmental Protection Agency, 2004a; PRC Environmental Management, Inc., 1993).

The objective of this study, done by the U.S. Geological Survey (USGS) in cooperation with the U.S. Environmental Protection Agency, was to determine if PCBs in all or parts of Devil's Swamp Lake are from historical discharges into the lake from the hazardous-chemical disposal facility wastewater drainage ditch. Attribution was attempted on the basis of (1) the spatial and temporal record of PCB inputs preserved in bed sediments in relation to the effluent discharge history of the disposal facility, (2) the chemical signature of PCBs preserved in bed sediment in the lake in comparison to the chemical signature of PCBs in bed sediment from the wastewater drainage ditch, and (3) relative concentrations of other anthropogenic contaminants (polycyclic aromatic hydrocarbons [PAHs] and trace elements [metals]) preserved in bed sediments as indicators of anthropogenic sources.

The purpose of this report is to document the findings of the study and describe sources of PCBs to Devil's Swamp Lake. Bed sediment samples were collected from the drainage ditch, and bed sediment cores were collected from several sites in Devil's Swamp Lake near where the drainage ditch enters the lake and down-lake to the west near where Bayou Baton Rouge enters the lake. Cores were split lengthwise, visually described, photographed, and selected intervals of the cores were subsampled. Sixty-one core subsamples and three drainage ditch bed sediment samples were analyzed for PCBs using an immunoassay screening method. On the basis of those results, 16 of the core subsamples and one drainage ditch bed sediment sample were analyzed for PCB congeners and other organic and inorganic constituents in the laboratory and interpreted to evaluate historical sources of PCBs to the lake.

Methods

Six bed sediment cores were collected from four sites in Devil's Swamp Lake and grab bed sediment samples were collected from three sites in the drainage ditch on October 5, 2004 (Van Metre and Wilson, 2004). Cores DSL.1 and DSL.2 were collected near each other from a site in the upper (east) end of the lake, east of the low spit of land where the drainage ditch enters the lake (fig. 1). This spit separates the upper end from the main body of the lake during low water. Cores DSL.3 and DSL.4 were collected near each other at the approximate lake center and about the same distance west of the spit as the locations of DSL.1 and DSL.2 were to the east or about 50 meters. Core DSL.5 was collected from a location about 300 meters southwest of where the drainage ditch enters the lake at the approximate lake center. Core DSL.6 was collected north of DSL.5, near the shore in front of a channel entering the lake from the large area of wetlands to the north and where Bayou Baton Rouge enters the lake. The bayou is a 248-square-kilometer watershed to the north and west of the lake. Three bed sediment samples were collected from the drainage ditch: DSL.A, on the spit of land about 40 meters into the lake from where the canal crosses the north shore of the lake; DSL.B, about even with the north shore of the lake; and DSL.C, about 40 meters upstream from the north shore of the lake. The spit of land containing the drainage ditch extends across the lake and the remains of the ditch banks and bottom were covered with vegetation during sampling in 2004. The spit probably represents the pre-dredging level of the wetland prior to lake construction in 1973. Except during floods, the spit is exposed and probably contained ditch flow as far as the middle of the lake, where erosion of the ditch banks was apparent in 2004. All three ditch samples were of the top 10 to 15 centimeters (cm) of bed sediment at the center of the 3- to 4-meter-wide canal and were scooped directly into glass jars.

Core Collection

Cores were collected using a 6.7-cm-diameter push corer with a polybutyrate liner attached to a check valve and an aluminum rod that is pushed into the lake bed sediment to obtain a core. The liners were washed with phosphate-free detergent and tap water prior to use and only used once. Cores were pushed into the bed sediment until firm sediment prevented further penetration. Sediment recovery ranged from 51 to 148 cm. Cores were returned to the USGS office in Austin, Tex., where they were sampled the following day. Each core was split lengthwise by cutting most of the way through the liner on opposite sides using a circular saw, cutting the rest of the way through using a utility knife, then slicing the sediment with a washed, Teflon-coated blade. Each core was photographed (fig. 2) and described. Description included color, texture, odor, and presence or absence of visible organic detritus, biota, and gas pockets. Subsamples of selected intervals from the cores were transferred to baked-glass or Nalgene jars for chemical analysis. Intervals were selected either using a constant length (for example, 5 cm) or on the basis of distinct changes in color and odor. Color changes were mostly alternating light (olive-gray) and dark (black) bands in the cores thought to correspond to less- and more-contaminated sediments, respectively. Sediments, especially in the dark layers, had a hydrocarbon odor. Subsamples for chemical analysis were scooped from the open liner using a Teflon-coated spatula taking care to not include material in contact with the walls of the liner. Subsampling tools were cleaned between each sample by rinsing with tap water, washing with phosphate-free detergent, and rinsing again with tap water. A subsample for analysis of organic compounds was transferred to a baked-glass jar and chilled pending shipment to the laboratory. A subsample for analysis of major and trace elements was transferred to a polypropylene jar, frozen, freeze-dried, and ground to a fine powder before shipment to the laboratory.

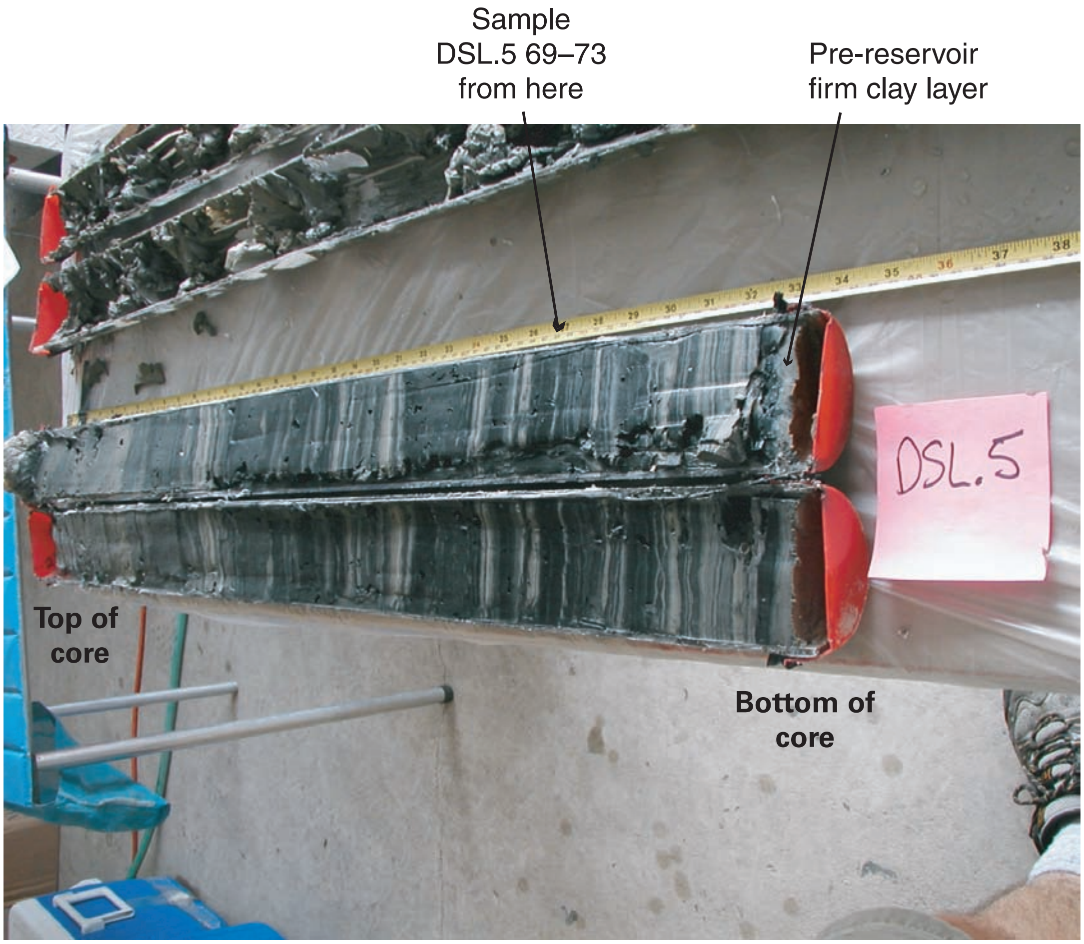


Figure 2. Core DSL.5 collected from Devil's Swamp Lake, Louisiana, October 5, 2004, split lengthwise for description and subsampling.

Chemical Analysis

Selected sediment samples were analyzed for total PCBs using the RaPID Assay® immunoassay kit (Strategic Diagnostics, Inc., 2004) as reported in Van Metre and Wilson (2004). A subset of samples analyzed by immunoassay were analyzed for organochlorine pesticides (OCs), PCBs, PAHs, and major and trace elements at the USGS National Water Quality Laboratory (NWQL).

Organochlorine pesticides, PCBs, PAHs, and alkyl-substituted PAHs (alkyl-PAHs) were extracted, isolated, and analyzed using the procedures of Noriega and others (2003) and Olson and others (2003). Briefly, wet bed sediment was extracted overnight with dichloromethane in a Soxhlet apparatus. The extract was reduced in volume and filtered. Two aliquots of the sample extract were quantitatively injected into a polystyrene-divinylbenzene gel permeation column and eluted with dichloromethane to remove sulfur and partially isolate the target analytes from coextracted high-molecular-weight interferences such as humic substances. The first aliquot was passed through a silica column cleanup step and then analyzed for PAHs and alkyl-PAHs by capillary-column gas chromatography with detection by mass spectrometry. Parent PAHs were identified and quantified by comparison to authentic standards. Individual alkyl-PAHs were quantified when authentic alkyl-substituted standards were available. The multiple isomeric alkyl-PAHs were quantified from mass chromatograms as the sum of all isomers at each alkylation level (C1-naphthalenes, C2-naphthalenes, and so forth). When authentic alkyl-substituted standards were unavailable, a parent PAH was used as the standard for quantification. Nineteen parent PAHs, 10 specific alkyl-PAHs, and the homologous series of alkyl-PAHs were determined. The second aliquot was further split into two fractions by combined alumina/silica adsorption chromatography followed by a micro Florisil column cleanup step prior to determination of the OCs and PCBs by dual capillary-column gas chromatography with electron capture detection (GC–ECD). The OCs were reported as individual compounds. PCBs were reported as individual Aroclor (1016/1242, 1254, or 1260) equivalents (Noriega and others, 2003).

For this study, fraction 1 (PCB fraction) of the second aliquot was analyzed for 27 (of 209 possible) PCB congeners (table 1) along with the other fraction 1 analytes during GC–ECD analysis. The congeners chosen for this analysis were some of the more dominant congeners in the most widely used Aroclors (1016, 1242, 1254, and 1260). In addition to the dominance of these congeners, potential co-elution issues and signal response for this analytical method also was considered. A series of dilutions of a custom mixture containing the 27 selected PCB congeners was used to make the calibration standards. Calibration standards were prepared at four levels and a minimum of three points was used for the calibration curves. An additional congener solution was prepared at a concentration that was mid-range on the curve and was used as a check standard to verify the calibration curve. The method reporting level (MRL) for PCB Aroclors is 5 micrograms per kilogram (μg/kg). An MRL has not been established for individual congeners because the analytical method is new; however, it is thought to be conservatively about 1 μg/kg. Concentrations less thanthe MRL were reported when the analyst was confident in the detection; those concentrations are identified in the tables of analytical results as estimated (E) (appendixes 1, 2). The quantification of individual congeners is thought to be more precise than the Aroclor equivalents; hence, the sum of the 27 congeners (ΣPCB_C) is used for most interpretations. A comparison of all samples indicated that ΣPCB_C accounted for 67 percent (mean), ±10 percent (1 standard deviation), of the sum of the Aroclors (ΣPCB_A).

Samples for analysis of major and trace elements were completely digested using a mixture of hydrochloric-nitric-perchloric-hydrofluoric acids and analyzed by inductively coupled plasma/mass spectrometry (Briggs and Meier, 2003). Mercury was analyzed by cold vapor atomic absorption spectrometry (Arbogast, 1996).

Quality Assurance

Quality assurance for chlorinated hydrocarbon compounds and PAH analyses was provided by analyzing laboratory duplicate, analytical blank, and spiked samples (appendixes 1, 2), and by monitoring recovery of surrogate compounds. The NWQL analyzes one duplicate, one analytical blank, and one spiked sample with each set of 12 environmental samples (not necessarily all from the same study) (Noriega and others, 2003; Olson and others, 2003). Two duplicate samples analyzed for this study (both for OCs and PCBs, although PCB congeners were not reported for one of the two) had a median relative percent difference (RPD) of 8.8 percent. There were no detections in the blank samples. Two blank samples (set numbers 200504607 and 200504608) were ruined during preparation at the laboratory, and no results were reported. Median spike recoveries for sample sets that included samples from this study were 84 percent for OCs and PCBs and 72 percent for PAHs. Spike recoveries met control limits in 78 percent of the OC and PCB and 99 percent of the PAH spike results. All spike results with poor recovery were above control limits. One spiked sample (set number 200503908) was ruined during preparation at the laboratory, and no results were reported. Surrogate recoveries were within acceptable ranges for 98 percent of the samples analyzed for OCs and PCBs, 93 percent of the samples analyzed for PAHs, and 96 percent of the blank and spiked samples. A problem was encountered during preparation of one OC and PCB sample (DSL.4 99–104) that required a 10-to-1 dilution, which subsequently raised the MRLs by a factor of 10.

Quality assurance for analyses of major and trace elements was provided by analyzing four standard reference materials (SRMs) (appendix 3). Median RPD for all elements for all SRMs was 3.4 percent.

Sources of Polychlorinated Biphenyls

Undisturbed bed sediment cores from lakes and reservoirs can be used to reconstruct contaminant release histories in the watershed for persistent, hydrophobic compounds like PCBs if a sediment chronology can be established (Eisenreich and others, 1989; Van Metre and others, 1998). In reservoirs, one useful date marker is the boundary between lacustrine sediment and pre-reservoir material (Van Metre and others, 1997; Van Metre and others, 2004). That interface usually is characterized by an abrupt change from soft, fine-grained, high-porosity sediment typical of lake-bottom environments to firmer, drier soil or sandy sediment. The nature of the pre-reservoir sediment varies depending on what existed at the location prior to the emplacement of the lake. Devil's Swamp Lake was created by dredging, so it is expected that material underlying the lacustrine sediment is an alluvial clay or a deeper soil horizon and that it is much firmer and of lower porosity than the overlying lacustrine sediment.

Six cores were collected using a push corer. Each time, the push corer initially encountered little resistance as it penetrated the lacustrine sediment, then encountered firm resistance, relatively suddenly, at depth. Maximum recovery was 148 cm at DSL.2. No obvious pre-reservoir material was recovered in the cores, with the possible exception of a 1-cm layer of firm, silty clay at the bottom of DSL.5 (fig. 2). The initial ease of penetration and the relatively abrupt resistance to penetration at depth indicate the corer could easily penetrate soft lacustrine sediment but was stopped by pre-reservoir soil or clay. Deposition dates for samples from cores DSL.2, DSL.4, and DSL.5 were assigned assuming cores penetrated almost to the pre-reservoir soil marking 1973, when dredging formed the lake, and assuming a constant mass accumulation rate of sediment for each core. Mass accumulation rate in each core was calculated using measured porosity and an assumed density of solids (2.0 grams per cubic centimeter, typical of lake sediments with moderate organic carbon content [Van Metre and others, 2004]) for sediment samples over the time interval thought to be represented by the core. The time interval was from 1975 (the bottom of the core, assuming the bottom was just above the late-1973

Table 1. Compound type, common name, abbreviation, and registry number for chlorinated hydrocarbon compounds.

[CAS, Chemical Abstracts Service; µg/kg, micrograms per kilogram --, none assigned]

Compound type	Compound common name	Abbreviation	CAS registry number	Method reporting level (µg/kg)
Organochlorine pesticides	Aldrin	--	309–00–2	2.0
	cis-Chlordane	--	5103–71–9	1.0
	trans-Chlordane	--	5103–74–2	.5
	p,p'-DDD	*p,p'*-DDD	72–54–8	2.5
	p,p'-DDE	*p,p'*-DDE	72–55–9	1.5
	p,p'-DDT	*p,p'*-DDT	50–29–3	1.0
	Dieldrin	--	60–57–1	.5
	Endosulfan I (alpha-Endosulfan)	--	959–98–8	.5
	Endrin	--	72–20–8	1.0
	Heptachlor	--	76–44–8	1.0
	Heptachlor epoxide (Isomer B)	--	1024–57–3	1.5
	gamma-Hexachlorocyclohexane (Lindane)	γ-HCH	58–89–9	.5
	Mirex	--	2385–85–5	1.5
	trans-Nonachlor	--	39765–80–5	1.0
	Toxaphene (technical)	--	8001–35–2	200
PCB Aroclors	PCB Aroclor 1016+1242	--	--	5
	PCB Aroclor 1254	--	11097–69–1	5
	PCB Aroclor 1260	--	11096–82–5	5
PCB congeners	PCB 8	--	34883–43–7	1
	PCB 18	--	37680–65–2	1
	PCB 22	--	38444–85–8	1
	PCB 26	--	38444–81–4	1
	PCB 28	--	7012–37–5	1
	PCB 31	--	16606–02–3	1
	PCB 33	--	38444–86–9	1
	PCB 44	--	41464–39–5	1
	PCB 49	--	41464–40–8	1
	PCB 52	--	35693–99–3	1
	PCB 70	--	32598–11–1	1
	PCB 95	--	38379–99–6	1
	PCB 101	--	37680–73–2	1
	PCB 110	--	38380–03–9	1
	PCB 118	--	31508–00–6	1
	PCB 138	--	35065–28–2	1
	PCB 146	--	51908–16–8	1
	PCB 149	--	38380–04–0	1
	PCB 151	--	52663–63–5	1
	PCB 170	--	35065–30–6	1
	PCB 174	--	38411–25–5	1
	PCB 177	--	52663–70–4	1
	PCB 180	--	35065–29–3	1
	PCB 183	--	52663–69–1	1
	PCB 187	--	52663–68–0	1
	PCB 194	--	35694–08–7	1
	PCB 206	--	40186–72–9	1
Surrogates				
	alpha-Hexachlorocyclohexane-d$_{\lambda}$	α-HCH-d$_{\lambda}$	434–90–2	--
	Isodrin	--	465–73–6	--
	2,2',3,3',4,4',5,6,6'-Nonachlorobiphenyl (PCB 207)	PCB-207	52663–79–3	--

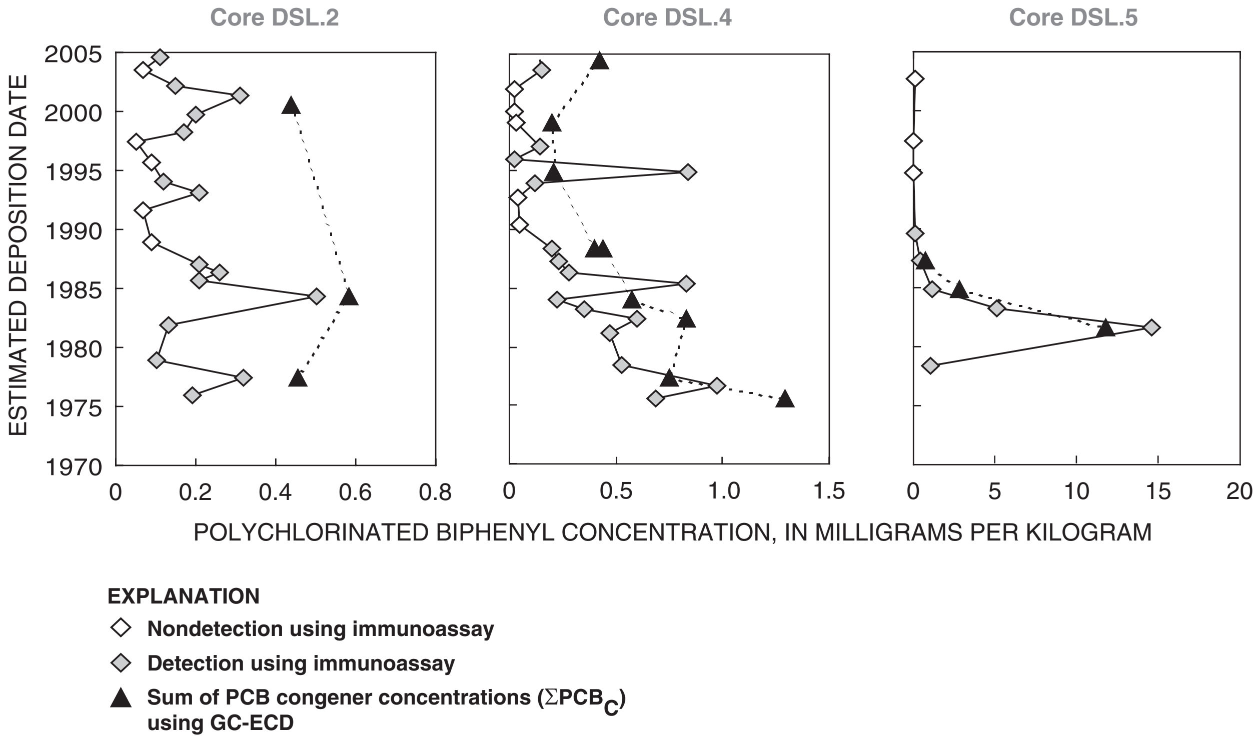


Figure 3. Concentrations of polychlorinated biphenyls (PCBs) in Devil's Swamp Lake, Louisiana, cores—comparison of immunoassay screening results and laboratory analyses using gas chromatography with electron capture detection (GC–ECD).

completion of dredging) to the sampling date in October 2004 (the top of the core). This approach is similar to the approach used by Van Metre and others (2004) for reservoir cores where a single depth-date marker was known at depth in the core, usually either the construction date of the reservoir or the peak in radioactive cesium-137 activity.

All five cores from along the axis of the lake (excluding core DSL.6) had alternating light and dark layering, with dark layers more common in deeper sediments (Van Metre and Wilson, 2004). DSL.2, for example, was a relatively uniform olive gray to a depth of 75 cm, then alternated between streaks of olive gray and black, some as thick as 2 cm, to the bottom of the core at 148 cm. Although the overall pattern of increasing numbers of dark sediment layers with increasing depth occurred in all five cores, there were differences between cores, and the dark layers could not be directly correlated between cores, even for cores collected close to one another.

Concentrations and Trends

PCBs were detected in about 70 percent of the 64 samples analyzed by immunoassay (excluding duplicates) (Van Metre and Wilson, 2004) and in all 16 samples analyzed in the laboratory (appendix 1). Immunoassay concentrations generally were lower than laboratory analyses of PCBs—the immunoassay results were 57 and 42 percent (median) of ΣPCB_C and ΣPCB_A concentrations, respectively—but reasonably represented the occurrence and patterns in trends (fig. 3). The highest concentrations were less than 58 cm (1985) in core DSL.5; the maximum ΣPCB_C concentration was 12,000 µg/kg in sample DSL.5 69–73 (1982). ΣPCB_A and the immunoassay concentrations were 20,000 and 14,500 µg/kg in this sample, respectively. The large, narrow peak in concentration and the nondetections using immunoassay in the upper part of the core indicate a short-term release for most of the PCBs and that the most contaminated bed sediment has since been buried by subsequent sediment deposition.

Concentrations of PCBs in cores DSL.4 and DSL.2 are about 10 to 20 times lower than the peak concentration in DSL.5 but are high compared with urban lake sediments in the United States and sediment-quality guidelines. The median ΣPCB_A concentrations in the 1970s and 1990s in 14 densely urban lakes (greater than 50-percent urban land use in the watershed) in 10 major urban areas across the United States were 275 and 108 µg/kg, respectively (Van Metre and Mahler, 2005). The probable effect concentration (PEC) for PCBs is 676 µg/kg (MacDonald and others, 2000). The PEC is the concentration above which adverse effects on benthic biota in freshwater systems are expected. The PEC does not consider bioaccumulation in wildlife and its consequences, such as human health risk from ingestion of contaminated fish. Concentrations of ΣPCB_A in DSL.4

range from 350 to 2,000 μg/kg and in DSL.2 range from 610 to 910 μg/kg (appendix 1). Temporal trends in these two cores are not as pronounced as in core DSL.5, although the decrease in ΣPCB_C over time in DSL.4 is statistically significant (using Kendall's tau: tau = -.79, p-value = .003).

Samples were collected from two sites to provide possible source characterization. Site DSL.6 is about 50 meters north of DSL.5 at the mouth of Bayou Baton Rouge, the main inflow to the lake (fig. 1). The drainage area of that inflow contains industrial land uses on the north side of Baton Rouge. Immunoassay results from DSL.6 indicated moderately high PCB concentrations (less than 90 to 960 μg/kg) and possibly a decrease over time (Van Metre and Wilson, 2004). The sample from DSL.6 with the highest immunoassay concentration (DSL.6 45–51) was analyzed at the laboratory and had a ΣPCB_C of 1,400 μg/kg (appendix 1). The other area sampled for source characterization is the wastewater drainage ditch. PCBs were detected using immunoassay in the three bottom-material samples from the ditch at 1,800 (DSL.A), 2,200 (DSL.B), and 1,200 (DSL.C) μg/kg for sites progressively toward the head of the ditch. Sample DSL.C was analyzed in the laboratory and had a ΣPCB_C concentration of 970 μg/kg. This sample was chosen because it was unlikely to have been influenced by any source other than the hazardous-chemical disposal facility.

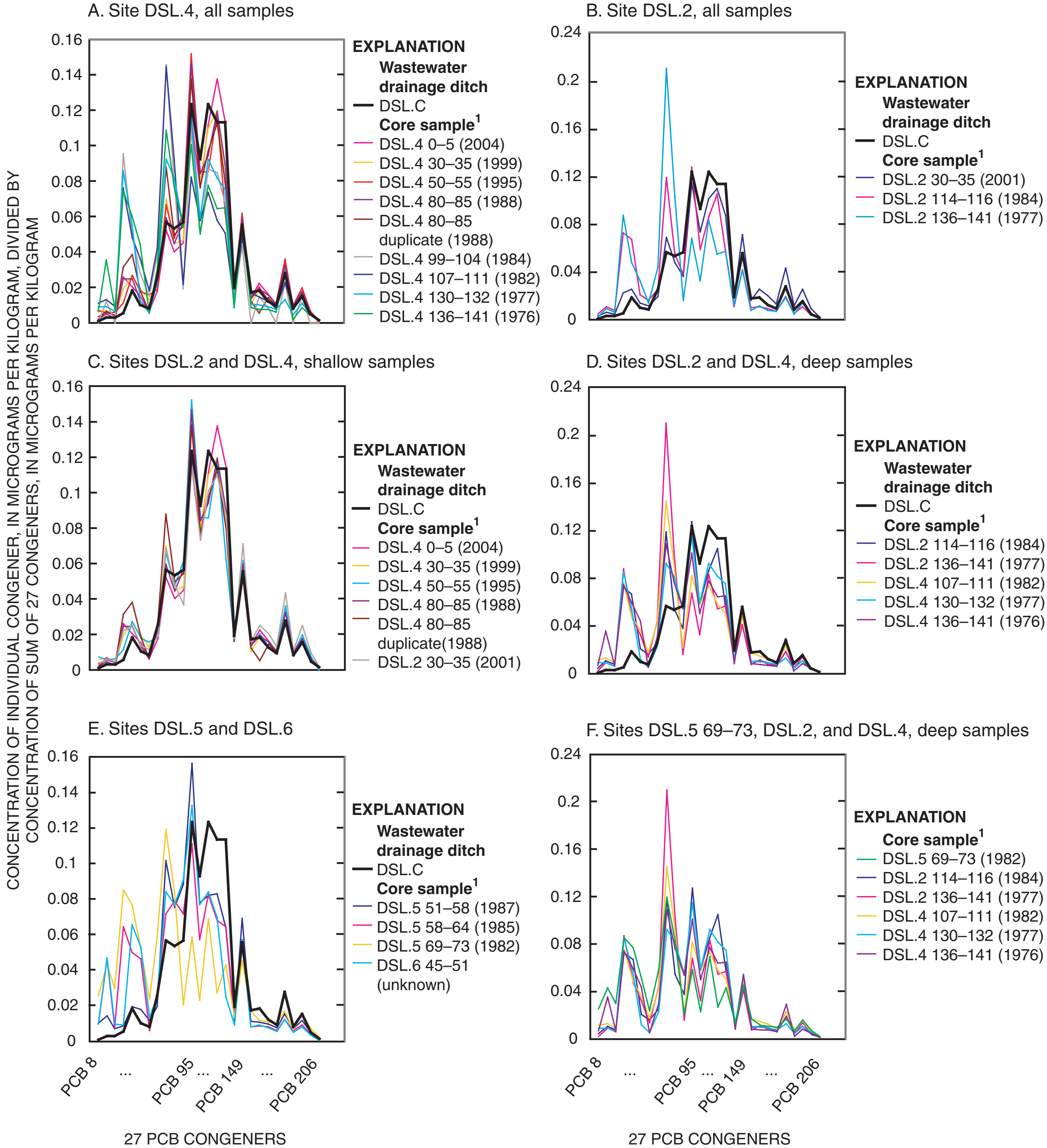
Polychlorinated Biphenyl Congener Patterns

Patterns of PCB congener distributions in samples of sediment, water, and tissue have been used to evaluate sources of PCBs (Besse and others, 2005; Johnson and others, 2000; Meharg and others, 2003; Monosson and others, 2003) and PCB transformations in the environment (Karcher and others, 2004). To facilitate comparison of samples with different total PCB concentrations, each congener concentration was divided by the ΣPCB_C concentration of the sample, yielding proportional values. Plots (profiles) of these patterns were overlaid to assess which samples were most like each other and which were different (fig. 4). The congener profile of DSL.C is shown on the first five plots (4A–E) as a bold black line. Profiles of DSL.4 and DSL.2 show similarities to that of DSL.C but with large peaks in a few less-chlorinated congeners in some samples (fig. 4A, B). The samples with those large peaks are all from the deep parts of the cores; samples from the shallow parts of these cores (deposited after the mid-1980s) are very similar to the ditch sample in their PCB congener profiles (fig. 4C). The next deep sample in both cores was dated as 1984. The deep samples have PCB signatures that are different from that of DSL.C but similar to each other (fig. 4D). This indicates either a change in the nature of PCB discharges from the ditch in the mid-1980s (for example, a shift in the dominant Aroclor mixture being processed at the facility and discharged through the ditch) or input of PCBs from some other source. Not surprisingly, there is a shift in the relative proportions of Aroclors as well as congeners in these cores (fig. 5). Aroclor 1016+1242 is less chlorinated than Aroclor 1254 or 1260 and accounts for a higher proportion of PCBs in the deep samples. Since the mid-1980s the Aroclor and congener fractions are quite stable, with Aroclor 1254 dominating, similar to that of sample DSL.C.

PCB congener profiles from all four of the samples from DSL.5 and DSL.6 are different from that of DSL.C, with the greatest difference in DSL.5 69–73 (fig. 4E), the sample with the highest concentration measured (12,000 μg/kg ΣPCB_C). Relatively high concentrations also were measured in shallow intervals in DSL.5 (dated as 1985 and 1987) and in the sample from DSL.6 (45–51 cm down core) (appendix 1). The much higher concentration in DSL.5 69–73 than in samples closer to and in the ditch (DSL.2, DSL.4 and DSL.C) and the very different congener profile indicate that the large peak in PCBs in DSL.5 is not from the ditch. The proximity of the site to the mouth of Bayou Baton Rouge indicates the source is in that watershed; but if so, the source(s) in Bayou Baton Rouge appears to have changed over time because DSL.5 69–73 and DSL.6 45–51 have different congener patterns (fig. 4E). The congener patterns in the two shallower samples from core DSL.5 are similar in many respects to those in sample DSL.6, but different from those in DSL.5 69–73 and DSL.C. With only one sample from DSL.6 analyzed and no deposition dating information for the core, it is possible that the sample (DSL.6 45–51) was deposited after sample DSL.5 69–73 was deposited. The DSL.6 site is in shallow water (1.0 meters), and the core had zones with sand and root hairs, which indicate periodic exposure during low-water periods and possibly periodic erosion. No attempt was made to assign dates to samples from core DSL.6 because of uncertainty as to how stable deposited sediment was at the site over time. The Bayou Baton Rouge source responsible for the PCB peak at site DSL.5 also could have affected sediments nearer to the ditch. The congener patterns in the deep samples from cores DSL.2 and DSL.4 are similar to the pattern in sample DSL.5 69–73 (fig. 4F), and all of these samples were dated as deposited in the late 1970s and early 1980s.

Multivariate Analysis of Polychlorinated Biphenyls

Multivariate statistical techniques are available that can facilitate the comparison of congener patterns among samples. The technique used here is extended Q-mode (EQ-mode) factor analysis (Miesch, 1976), which was chosen because it is designed to work with compositional (proportional) data. As with all factor analytical techniques, the EQ-mode method is used to detect underlying structure in a multivariate dataset. A Q-mode analysis evaluates similarities between objects (samples) to discern patterns or groups that provide both classification of samples and explanation of provenance or sample origin (Davis, 1986). Each congener concentration was divided by the ΣPCB_C concentration for the sample to convert concentrations to proportions of the total. When analyzing proportional data using factor analysis, a complication arises in that each row of data sums to a constant value (1 in this case), causing what it known as "closure" or the forced correlation among variables.



[1]Range in sample identifier indicates sample depth (centimeters) down core. Estimated sediment deposition date of samples follows in parenthesis.

Figure 4. Polychlorinated biphenyl (PCB) congener patterns in various groups of bed sediment samples collected in and near Devil's Swamp Lake, Louisiana.

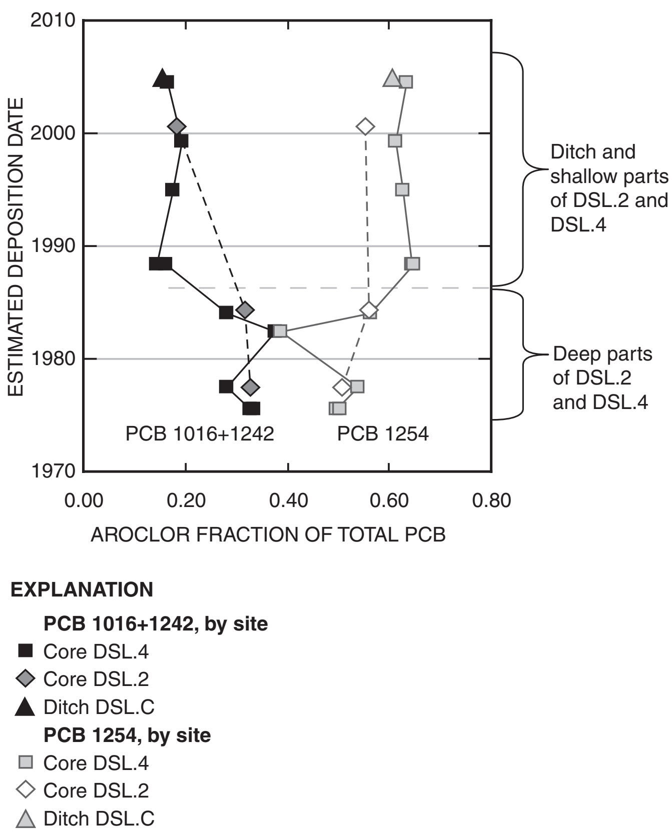


Figure 5. Temporal shifts in relative concentrations (to total) of polychlorinated biphenyl (PCB) Aroclors in Devil's Swamp Lake, Louisiana, bed sediments.

The special routines of EQ-mode analysis were developed to handle such data (Miesch, 1976).

Results of EQ-mode factor analysis are expressed as compositional loadings for each sample. These loadings represent the proportion of each end-member in a given sample. On the basis of eigenvalues and the evaluation of plots of congener profiles (fig. 4), three end-members adequately accounted for the variance in PCB congener composition among the samples. Three factors were determined using EQ-mode analysis and varimax normalized rotation, an orthogonal rotation technique that maximizes the variance of the elements in the columns of a factor matrix. These three factors accounted for 81.3 percent of the variance in the data. Scores that represent an idealized composition of the end-members in terms of the congeners and compositional loadings for samples are listed in tables 2 and 3, respectively. Because the loadings are compositional, they sum to 1 for each sample.

Plotting compositional loadings on a tri-linear graph indicates which samples are most similar to the end-members, which samples should represent distinct sources, and which samples are most affected by those sources (fig. 6). DSL.C is most similar to end-member 1, indicating that this end-member represents sediment influenced by the wastewater drainage ditch source. Samples DSL.5 69–73 and DSL.6 45–51 are most similar to end-members 2 and 3, respectively, indicating two other PCB sources. The locations of cores DSL.5 and DSL.6 near the mouth of Bayou Baton Rouge and the different compositional loadings from samples near the wastewater drainage ditch, including DSL.C, indicate Bayou Baton Rouge as the source of end-members 2 and 3. As noted above, the deposition date of DSL.6 45–51 is unknown, and it is possible that this sample and DSL.5 69–73 represent Bayou Baton Rouge sources active during different time periods.

Table 2. Scores for factors representing three end-members determined using EQ-mode factor analysis of polychlorinated biphenyl (PCB) congener concentrations in bed sediment from Devil's Swamp Lake, Louisiana.

Congener	Factor 1	Factor 2	Factor 3
PCB 8	-0.01214	0.01647	0.01866
PCB 18	-.05722	.01661	.11603
PCB 22	-.01230	.02203	.01145
PCB 26	-.07536	.23367	-.06497
PCB 28	-.05172	.10364	.07816
PCB 31	-.04802	.05029	.09132
PCB 33	.00249	.02630	.00095
PCB 44	-.00900	.08080	.00008
PCB 49	-.03516	.30550	-.03231
PCB 52	-.02393	.13889	.08125
PCB 70	.05620	-.07520	.22721
PCB 95	.20932	-.02979	.21394
PCB 101	.14710	-.03802	.10949
PCB 110	.15435	.04733	.06731
PCB 118	.24214	-.01771	.04430
PCB 138	.17339	.02943	-.01036
PCB 146	.02834	.00916	.00157
PCB 149	.07897	.01149	.08513
PCB 151	.02158	.01368	-.00277
PCB 170	.03775	.00743	-.00922
PCB 174	.02784	.00450	-.00101
PCB 177	.01833	.00688	-.00186
PCB 180	.06412	.01226	-.01231
PCB 183	.01838	.00222	-.00060
PCB 187	.03238	.01425	-.00990
PCB 194	.01010	.00504	-.00034
PCB 206	.00209	.00285	-.00118

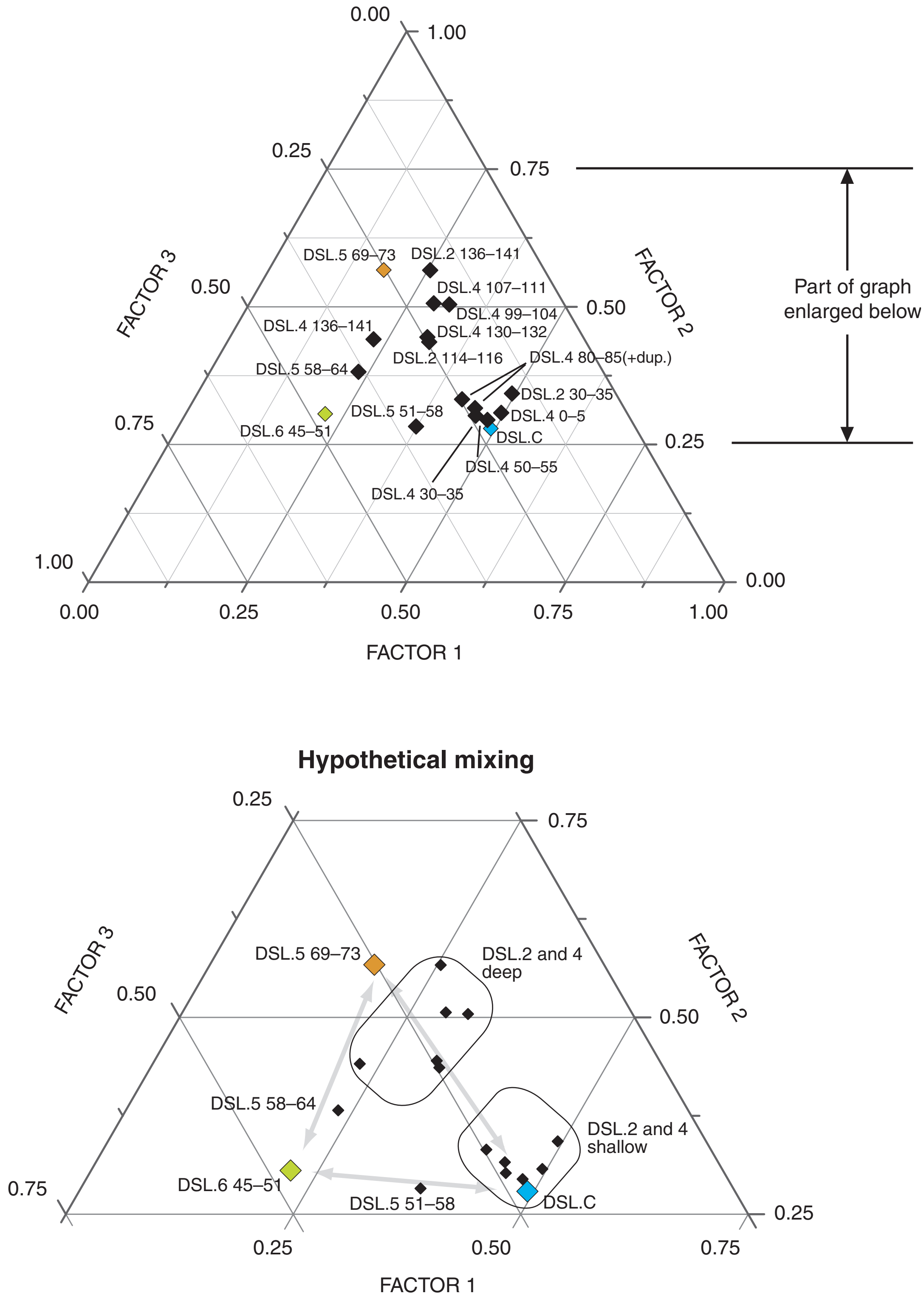


Figure 6. Factor loadings determined using proportions of polychlorinated biphenyl (PCB) congeners in samples from Devil's Swamp Lake, Louisiana. Plotting positions of points on the two graphs are the same.

Table 3. Compositional loadings of three end-members based on EQ-mode factor analysis for bed sediment samples from Devil's Swamp Lake, Louisiana.

[lab. dup., laboratory duplicate]

Sample	Factor 1	Factor 2	Factor 3
DSL.2 30–35	0.494	0.343	0.163
DSL.2 114–116	.310	.445	.245
DSL.2 136–141	.254	.566	.180
DSL.C	.493	.279	.228
DSL.4 0–5	.495	.308	.198
DSL.4 30–35	.450	.316	.235
DSL.4 50–55	.458	.302	.240
DSL.4 80–85	.480	.295	.226
DSL.4 80–85 lab. dup.	.421	.332	.247
DSL.4 99–104	.315	.504	.181
DSL.4 107–111	.290	.506	.204
DSL.4 130–132	.317	.436	.247
DSL.4 136–141	.228	.441	.331
DSL.5 51–58	.374	.283	.344
DSL.5 58–64	.233	.382	.385
DSL.5 69–73	.181	.567	.253
DSL.6 45–51	.219	.306	.475

PCBs in all of the other samples are mixtures of the three end-members (fig. 6). Samples that are most similar to DSL.C and are strongly affected by the drainage ditch (end-member 1) include all of the shallow (post mid-1980s) samples from DSL.2 and DSL.4. Samples from the deeper parts of cores DSL.2 and DSL.4 plot between DSL.5 69–73 and DSL.C, indicating a mixture of the ditch and Bayou Baton Rouge sources. Only two samples plot relatively closer to DSL.6 45–51, and both are from DSL.5 up-core from sample DSL.5 69–73 (more recently deposited).

The hypothesis that DSL.5 and DSL.6 are affected by Bayou Baton Rouge sources and that there was a temporal shift in those sources is supported by the factor analysis. Sample DSL.5 58–64, deposited about 2 years after DSL.5 69–73, is a mixture of end-members 2 and 3. Sample DSL.5 51–58, deposited about 2 years after DSL.5 58–64 (1987), is a mixture of end-members 3 (DSL.6) and 1 (DSL.C). This shift in the mixture of sources in the shallower (more recent) samples from DSL.5 is consistent with a temporal shift and decrease in importance in sources from Bayou Baton Rouge. Bayou Baton Rouge appears to have been a large source of PCBs to Devil's Swamp Lake only during the early 1980s. The PCB concentration in sample DSL.5 77–83 (deposited about 1978) was 1,000 μg/kg by immunoassay, one-twentieth the concentration in DSL.5 69–73. PCB concentrations were low or not detected (150 μg/kg or less by immunoassay) in the four samples from core DSL.5 deposited after about 1988 and low or not detected (330 μg/kg or less) in the three samples deposited after sample DSL.6 45–51 in core DSL.6 (fig. 3) (Van Metre and Wilson, 2004).

Metals and Polycyclic Aromatic Hydrocarbons as Source Indicators

Corroboration of different PCB sources to the middle-lake (DSL.5 and DSL.6) and upper-lake (DSL.2 and DSL.4) coring sites is provided by analyses of other anthropogenic contaminants in the cores. There are large differences in concentrations of antimony, cadmium, mercury, zinc, and PAHs among cores (fig. 7). Concentrations of four of five constituents (excluding cadmium) and the PAH source ratio shown in figure 7 are very different in sample DSL.5 69–73 than constituent concentrations and the PAH source ratio in cores DSL.2 and DSL.4. Differences in PAHs are especially notable. Concentrations of ΣPAH_{SQG} (the summation used for the consensus-based sediment-quality guideline [Ingersoll and others, 2000]) are 37 times greater on average in sample DSL.5 69–73 than in the upper-lake cores, and the PAH assemblage is different. Petrogenic sources of PAHs (fuels) are dominated by the lower molecular weight (2- and 3-ringed) PAHs and alkyl-PAHs, whereas pyrogenic sources (combustion products) are dominated by the higher molecular weight (4-ringed and greater) parent compounds. The ratio of 2- and 3-ringed PAH plus alkyl-PAH to 4- and 5-ringed parent PAH (2+3/comb) indicates the relative dominance of pyrogenic (ratios less than about 1) or petrogenic PAHs (Van Metre and others, 2000). The 2+3/comb ratio in sample DSL.5 69–73 indicates a strongly petrogenic source (value of 4.0), whereas the sources of PAHs to the upper-lake cores are both pyrogenic and petrogenic (1.1 ± 0.55). Thus, the mixture of contaminants in sample DSL.5 69–73 is different from those of other sites in the lake, including all samples from nearer the wastewater drainage ditch, and different from those of shallower zones in the same core.

Historical Data Regarding a Second Source

Support for the hypothesis of two different sources of PCBs also can be found in the historical data. The most comprehensive historical sampling at Devil's Swamp Lake was done in 1992 by PRC Environmental Management, Inc. (PRC), for the U.S. Environmental Protection Agency (PRC Environmental Management, 1993). PRC collected bed sediment grab samples from 15 sites in the part of Devil's Swamp Lake that this study sampled and from two sites in the wastewater drainage ditch (fig. 8) and detected elevated concentrations of PCBs at many sites. The highest concentrations in the PRC samples were from sites at the mouth of Bayou Baton Rouge, and relatively high concentrations were detected in samples from sites near the

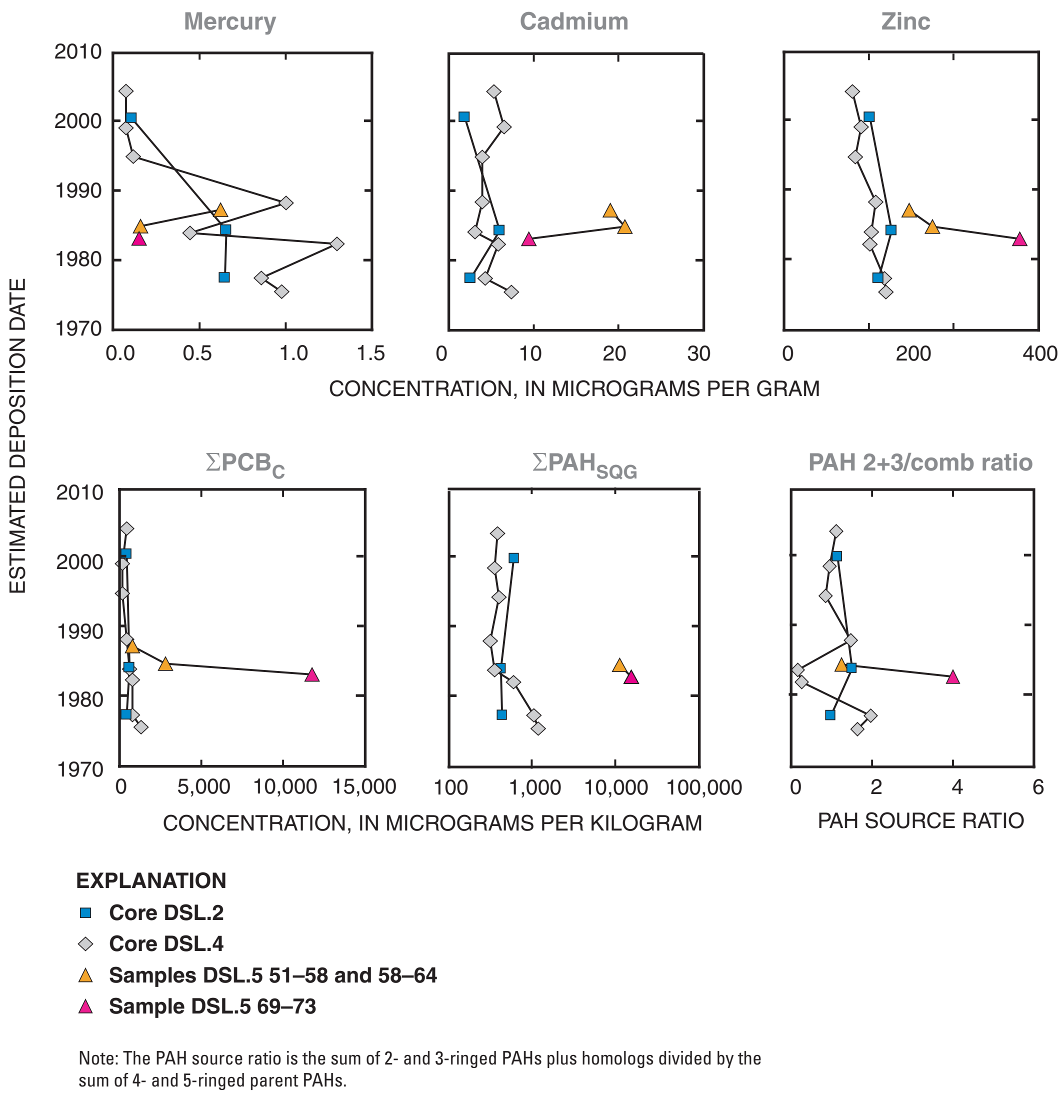


Figure 7. Temporal trends in concentrations of selected metals, the sum of polychlorinated biphenyl congeners (ΣPCB_C), the sum of selected polycyclic aromatic hydrocarbons (ΣPAH_{SQG}), and the PAH source ratio (PAH 2+3/comb ratio) in cores DSL.2, DSL.4, and DSL.5, Devil's Swamp Lake, Louisiana.

mouth of the drainage ditch and the far east end of the lake. Although there are differences in concentrations from the PRC study and this study, the general pattern of concentrations in samples from the USGS cores dated as deposited in the 1980s is similar to the pattern of PRC concentrations. It is unlikely that the PCBs in the samples near the mouth of Bayou Baton Rouge came from the drainage ditch because they are at higher concentrations than samples near the mouth of the ditch. Higher concentrations in bottom sediments farther from an inflow source can occur if, for example, the area closer to the inflow is a shallower or higher-energy environment, or both (resulting in primarily sandy sediments), and the area farther away is deeper and calmer, where fine-grained sediments accumulate. This, however, is not the case for the applicable part of Devil’s Swamp Lake. Water depth was 2.4 meters at sites DSL.2, DSL.4, and DSL.5. Particle size was not analyzed in these samples, but aluminum, an element strongly associated with clays and sometimes used to normalize sediment samples for the effects of surface area, had similar concentrations in the cores (range from 59,400 to 87,600 micrograms per gram) (appendix 3).

PAHs also were measured by PRC, and the concentration distribution is consistent with that from this study and the conclusion of two sources of contamination to the lake. Much higher ΣPAH_{SQG} concentrations were detected by PRC in samples with high PCBs at the mouth of Bayou Baton Rouge than in samples from near the wastewater drainage ditch and from the far east end of the lake (fig. 8B). Viewing the PAHs as tracers of anthropogenic contamination, it appears that the contamination that entered Devil’s Swamp Lake from Bayou Baton

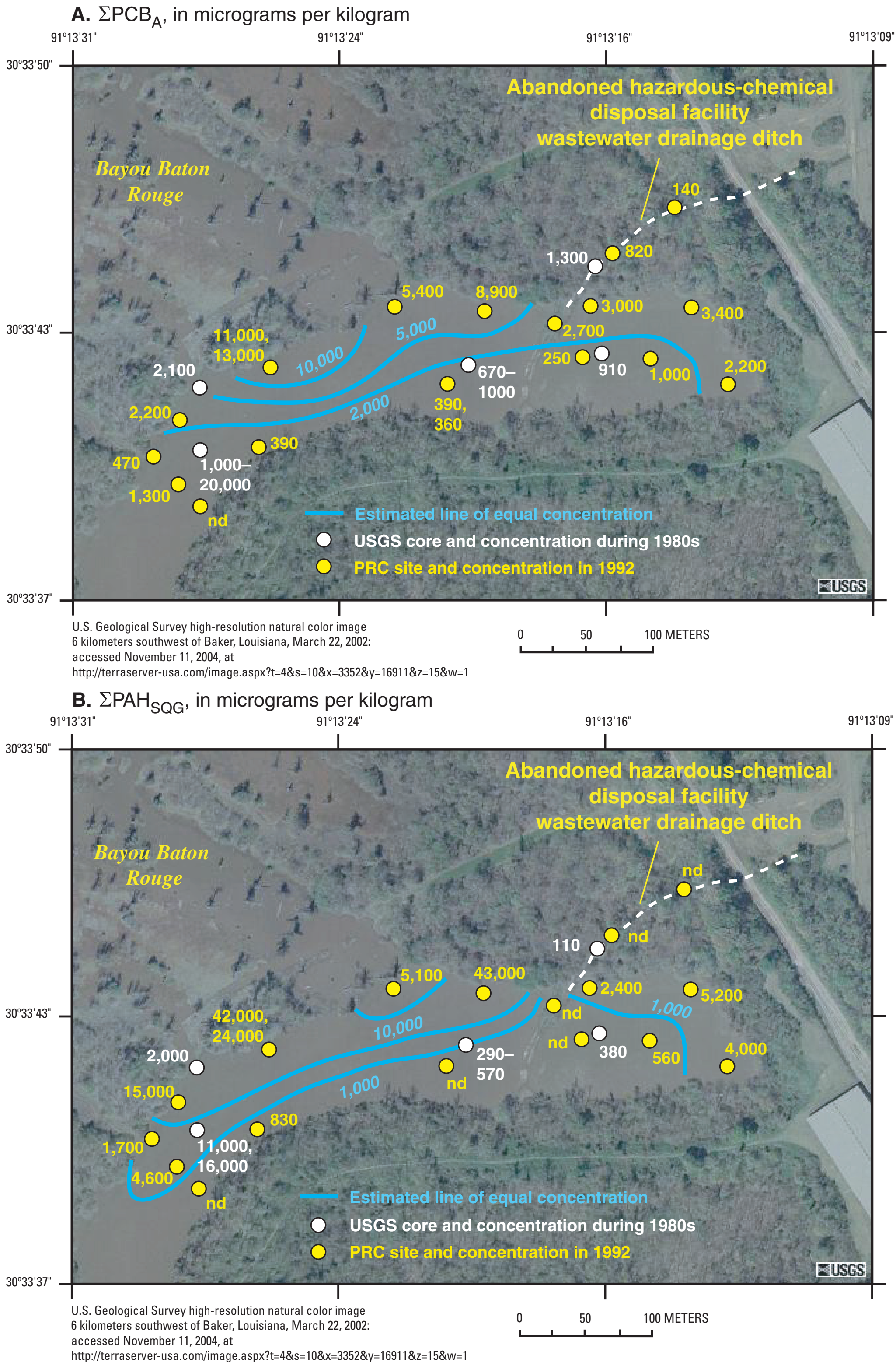


Figure 8. Aerial images of Devil’s Swamp Lake, Louisiana, showing concentrations of (A) the sum of polychlorinated biphenyl Aroclors (ΣPCB$_A$) and (B) the sum of 13 polycyclic aromatic hydrocarbon compounds used for the probable effects concentration (ΣPAH$_{SQG}$ [Ingersoll and others, 2000]) in U.S. Geological Survey (USGS) core samples dated as mid-1980s and in grab samples collected in 1992 by PRC Environmental Management, Inc. (PRC Environmental Management, Inc., 1993). Lines of equal concentration on both maps are based on the PRC data. [nd = nondetection for all compounds in summations; nd for individual compounds treated as zero values in summations]

Rouge had high concentrations of PCBs and PAHs, whereas the contamination that entered from the wastewater drainage ditch had high concentrations of PCBs but low concentrations of PAHs (fig. 8). A similar conclusion, higher concentrations from the Bayou Baton Rouge source, can be drawn for most metals. Metals with notably higher concentrations in cores DSL.5 and DSL.6 (and sample DSL.5 69–73) compared with those in cores DSL.2 and DSL.4 include antimony, arsenic, cadmium, chromium, lead, nickel, and zinc (appendix 3).

The duration of the PCB inputs varied as well, with a relatively short period of input from Bayou Baton Rouge and a much longer period of input from the drainage ditch. The short period of input from Bayou Baton Rouge is indicated by PCB concentration trends in core DSL.5 (fig. 3) and by the PCB congener profiles in deeper, older samples from DSL.2 and DSL.4 that show inputs from the Bayou Baton Rouge source(s) only in intervals deposited in the late 1970s and early 1980s (fig. 4D). The long duration of PCB inputs from the drainage ditch is indicated by PCB concentrations and congener profiles in cores DSL.2 and DSL.4, which indicate a mixture of sources (Bayou Baton Rouge and the drainage ditch) in the late 1970s and early 1980s and primarily the drainage ditch source after the mid-1980s. On the basis of the elevated PCB concentrations (greater than the median of 108 μg/kg from urban lakes and in many cases greater than the PEC of 676 μg/kg) in recent (post-2000) drainage ditch sediment and in recently deposited sediments at DSL.2 and DSL.4, some PCB inputs from the ditch might still be occurring.

The identity of the Bayou Baton Rouge source(s) could not be established using available data. The short duration and relatively high concentration of PCBs from the bayou source (as indicated by PCB concentration trends in core DSL.5 and concentration in sample DSL.5 69–73) indicate either a spill or a flood-related release. There was a large flood on the Mississippi River in 1983, and a sediment plume was visible emanating from a natural drainage channel from the hazardous-chemical disposal facility in an aerial photograph taken in 1984 (U.S. Environmental Protection Agency, 2004b). The natural channel entered Bayou Baton Rouge upstream from Devil's Swamp Lake and flowed through a "soil-borrow pit" at the disposal facility that was filled with "standing-liquid" pits. Other industrial and waste-processing facilities are in the watershed of Bayou Baton Rouge (Agency for Toxic Substances and Disease Registry, 1996). PCB congener data and other chemical data that might help identify sources, however, are not available from the other disposal facility channel(s), Bayou Baton Rouge, or other industrial sites in its watershed. If the source was the disposal facility by way of another channel, it must have come from a very different waste stream than material discharged by the wastewater drainage ditch sampled in this study. Alternatively, if the source was another facility farther upstream, a chemical record of those releases during the early 1980s might not be preserved in bottom sediments in Bayou Baron Rouge because of the dynamic nature of stream channels, where higher flows can remobilize and transport deposited sediments.

Summary

Devil's Swamp Lake near Baton Rouge, La., created by dredging in 1973 in Devil's Swamp along the Mississippi River, is contaminated with PCBs from historical industrial discharges. This report describes a study, done by the U.S. Geological Survey in cooperation with the U.S. Environmental Protection Agency, involved investigation of the occurrence and sources of PCBs in the lake, including the possible historical contribution of PCBs from a hazardous-chemical disposal facility by way of a wastewater drainage ditch that was used from 1971 to 1993. Six bed sediment cores from the lake and three bed sediment grab samples from the drainage ditch were collected; 61 subsamples from five of the six cores and the three grab samples from the ditch were analyzed for PCBs using an immunoassay screening method. Sixteen of the core subsamples and one ditch sample were analyzed for organochlorine pesticides, PCBs as Aroclor mixtures and as 27 specific congeners, PAHs (15 samples), and major and trace elements. The immunoassay screening method reasonably represented the overall patterns in concentrations in the laboratory analytical data.

The highest concentration of PCBs was in a sample deposited in about 1983 in core DSL.5, about 300 meters southwest of where the drainage ditch enters the lake and near the mouth of Bayou Baton Rouge. The PCB profile in this core defined a sharp peak in the early 1980s, with low concentrations after about 1990, indicating a short-term release in the early 1980s. Concentrations decreased much more slowly in core DSL.4 and have remained variable but elevated over the past 25 years in core DSL.2, both of those sites about 50 meters west and east, respectively, from the low spit of land that marks the entrance of the ditch into the lake. PCBs were elevated in three samples of bed sediment from the ditch analyzed by immunoassay and confirmed in the one sample analyzed using GC–ECD at the laboratory.

PCB congener profiles and a factor analysis of congener composition indicate that PCBs in bed sediment from the drainage ditch and in lake bed sediment deposited near the ditch (cores DSL.2 and DSL.4) since the mid-1980s are similar, which indicate the hazardous-chemical disposal facility, by way of the wastewater drainage ditch, is the source of the PCBs. Bed sediment from several hundred meters to the west, near where Bayou Baton Rouge enters the lake (cores DSL.5 and DSL.6), had a different PCB composition, and in one sample deposited in the early 1980s, a much higher concentration, which indicates a second source of PCBs in the watershed of Bayou Baton Rouge. Large differences in PAHs and metals in cores from the two areas of the lake support the conclusion that there was a second PCB source. Older (deeper) samples from cores near the ditch (before the mid-1980s; cores DSL.2 and DSL.4) had PCB compositions indicating a mixture of the ditch source and the Bayou Baton Rouge source.

PCB profiles in the sediment cores indicate that the Bayou Baton Rouge source was large but of short duration, whereas

the drainage ditch source appears to have introduced PCBs to the lake at relatively steady, elevated levels, since the lake was formed. The long duration of PCB releases from the drainage ditch source is indicated by PCB concentrations and congener profiles in cores DSL.2 and DSL.4, which reflect a mixture of sources (Bayou Baton Rouge and the drainage ditch) in the late 1970s and early 1980s and primarily the drainage ditch source after the mid-1980s. Elevated PCB concentrations (greater than the median of 108 µg/kg from urban lakes and in many cases above the PEC of 676 µg/kg) in recent (pre-2000) drainage ditch sediment and in recently deposited sediment at DSL.2 and DSL.4 indicate that some PCB inputs from the ditch might still be occurring.

The identity of the Bayou Baton Rouge source(s) could not be established using available data. The short duration and relatively high concentrations of PCBs of the bayou source (as indicated by PCB concentration trends in core DSL.5 and concentration in sample DSL.5 69–73) indicate either a spill or a flood-related release—there was a large flood on the Mississippi River in 1983.

Selected References

Arbogast, B.F, ed., 1996, Analytical methods manual for the Mineral Resource Surveys Program: U.S. Geological Survey Open-File Report 96–525, 248 p.

Agency for Toxic Substances and Disease Registry, 1996, Public health assessment—Petro-Processors of Louisiana Incorporated, Baton Rouge, East Baton Rouge Parish, Louisiana: Agency for Toxic Substances and Disease Registry, accessed June 19, 2006, at http://www.atsdr.cdc.gov/HAC/PHA/petro/pet_p1.html

Besse, R.E., Van Metre, P.C., and Wilson, J.T., 2005, Distribution and sources of polychlorinated biphenyls in Woods Inlet, Lake Worth, Fort Worth, Texas, 2003: U.S. Geological Survey Scientific Investigations Report 2005–5064, 46 p.

Briggs, P.H., and Meier, A.L., 2003, The determination of forty-two elements in geological materials by inductively-coupled plasma-mass spectrometry for NAWQA, *in* Taggart, J.E.J., ed., Analytical methods for chemical analysis of geologic and other materials, U.S. Geological Survey: U.S. Geological Survey Open-File Report 2002–223, 16 p.

Davis, J.C., 1986, Statistics and data analysis in geology (2d ed.): New York, Wiley, 646 p.

Davis, R.B., 1980, The scope of Quaternary paleolimnology, *in* Davis, R.B., ed., Paleolimnology and the reconstruction of ancient environments: Boston, Kluwer Academic, p. 1–24.

Eisenreich, S.J., Capel, P.D., Robbins, J.A., and Boubonniere, R.A., 1989, Accumulation and diagenesis of chlorinated hydrocarbons in lacustrine sediments: Environmental Science and Technology, v. 23, no. 9, p. 1,116–1,126.

Ingersoll, C.G., MacDonald, D.D., Wang, N., Crane, J.L., Field, L.J., Haverland, P.S., Kemble, N.E., Lingskoog, R.A., Severn C., and Smorong, D.E., 2000, Prediction of sediment toxicity using consensus-based freshwater sediment quality guidelines: U.S. Environmental Protection Agency EPA 905/R-00/007, 25 p.

Johnson, G.W., Jarman, W.M., Bacon, C.E., Davis, J.A., Ehrlich, R., and Risenbough, R.W., 2000, Resolving polychlorinated biphenyl source fingerprints in suspended particulate matter of San Francisco Bay: Environmental Science and Technology, v. 34, no. 4, p. 552–559.

Karcher, S.C., Small, J.M., and Vanbriesen, J.M., 2004, Statistical method to evaluate the occurrence of PCB transformations in river sediments with application to Hudson River data: Environmental Science and Technology, v. 38, no. 24, p. 6,760–6,766.

MacDonald, D.D., Ingersoll, C.G., and Berger, T.A., 2000, Development and evaluation of consensus-based sediment quality guidelines for freshwater ecosystems: Archives of Environmental Contamination and Toxicology, v. 39, p. 20–31.

Meharg, A.A., Wright, J., Leeks, G.J.L., Wass, P.D., Owens, P.N., Walling, D.E., and Osborn, D., 2003, PCB congener dynamics in a heavily industrialized river catchment: The Science of the Total Environment, v. 314–316, p. 439–450.

Miesch, A.T., 1976, Interactive computer programs for petrologic modeling with extended Q-mode factor analysis: Computers and Geosciences, v. 2, p. 439–492.

Monosson, E., Ashley, J.T.F., McElroy, A.E., Woltering, D., and Elshus, A.A., 2003, PCB congener distributions in muscle, liver and gonad of *Fundulus heteroclitus* from the lower Hudson River Estuary and Newark Bay: Chemosphere, v. 52, p. 777–787.

Noriega, M.C., Wydoski, D.S., and Foreman, W.T., 2003, Methods of analysis by the U.S. Geological Survey National Water Quality Laboratory—Determination of organochlorine pesticides and polychlorinated biphenyls in bottom and suspended sediment by gas chromatography with electron-capture detection: U.S. Geological Survey Water-Resources Investigations Report 03–4293, 46 p.

Olson, M.C., Iverson, J.L., Furlong, E.T., and Schroeder, M.P., 2003, Methods of analysis by the U.S. Geological Survey National Water Quality Laboratory—Determination of polycyclic aromatic hydrocarbon compounds in sediment by gas chromatography/mass spectrometry: U.S. Geological Survey Water-Resources Investigations Report 03–4318, 45 p.

Potts, P.J., Tindle, A.G., and Webb, P.C., 1992, Geochemical reference material compositions—Rocks, minerals, sediments, soils, carbonates, refractories, and ores used in research and industry: Boca Raton, Fla., CRC Press, 313 p.

PRC Environmental Management, Inc., 1993, Expanded site inspection for Devil's Swamp Lake, East Baton Rouge Parish, Louisiana—Final report: U.S. Environmental Protection Agency LAD985202464.

Strategic Diagnostics, Inc., 2004, Remediation, assessment, & industrial testing: RaPID Assay, [description], accessed October 2, 2006, at http://www.sdix.com/PDF/Products/rapcbpp.pdf

U.S. Environmental Protection Agency, 1997, The incidence and severity of sediment contamination in surface waters of the United States: Volume 1—National sediment quality survey: U.S. Environmental Protection Agency EPA 823–R–97–006.

U.S. Environmental Protection Agency, 2004a, Devil's Swamp Lake, Baton Rouge, Louisiana: U.S. Environmental Protection Agency, accessed June 19, 2006, at http://www.epa.gov/earth1r6/6sf/pdffiles/devils_swamp.pdf

U.S. Environmental Protection Agency, 2004b, Aerial photographic analysis of Devil's Swamp Lake site, Scotlandville, Louisiana: U.S. Environmental Protection Agency Report no. TS–PIC–20506006S.

U.S. Environmental Protection Agency, 2006, Polychlorinated biphenyls (PCBs): U.S. Environmental Protection Agency, accessed June 19, 2006, at http://www.epa.gov/pcb/index.html

Van Metre, P.C., Callender, Edward, and Fuller, C.C., 1997, Historical trends in organochlorine compounds in river basins identified using sediment cores from reservoirs: Environmental Science and Technology, v. 31, no. 8, p. 2,339–2,344.

Van Metre, P.C., and Mahler, B.J., 2005, Trends in hydrophobic organic contaminants in lake sediments across the United States, 1970–2001: Environmental Science and Technology, v. 39, no. 15, p. 5,567–5,574.

Van Metre, P.C., Mahler, B.J., and Furlong, E.T., 2000, Urban sprawl leaves its PAH signature: Environmental Science and Technology, v. 34, p. 4,064–4,070.

Van Metre, P.C., and Wilson, J.T., 2004, Immunoassay screening of sediment cores for polychlorinated biphenyls, Devil's Swamp Lake near Baton Rouge, Louisiana, 2004: U.S. Geological Survey Open-File Report 2004–1397, 10 p.

Van Metre, P.C., Wilson, J.T., Callender, Edward, and Fuller, C.C., 1998, Similar rates of decrease of persistent, hydrophobic contaminants in riverine systems: Environmental Science and Technology, v. 32, no. 21, p. 3,312–3,317.

Van Metre, P.C., Wilson, J.T., Fuller, C.C., Callender, Edward, and Mahler, B.J., 2004, Collection, analysis, and age-dating of sediment cores from 56 U.S. lakes and reservoirs sampled by the U.S. Geological Survey, 1992–2001: U.S. Geological Survey Scientific Investigations Report 2004–5184, 180 p.

Blank Page

Appendix 1—Analytical Results for Selected Chlorinated Hydrocarbon Compounds

Appendix 1. Analytical results for selected chlorinated hydrocarbon compounds from samples collected October 5, 2004, from Devil's Swamp Lake, Louisiana.

[In micrograms per kilogram except as indicated. Concentration in bold exceeds probable effect concentration (MacDonald and others, 2000). ID, identifier; <, nondetection at indicated value; E, estimated; --, not calculated; lab dup, laboratory duplicate; lab, laboratory; nr, not reported]

Sample ID and interval (centimeters), where applicable	Estimated deposition date	Laboratory set number	*p,p'*-DDD	*p,p'*-DDE	*p,p'*-DDT	Dieldrin	Heptachlor epoxide
DSL.2 30–35	2001	200503908	<2.5	1.8	<1.0	<0.5	<1.0
DSL.2 114–116	1984	200503908	<5.0	E1.5	<2.0	<1.0	<2.0
DSL.2 136–141	1977	200503908	1.3	1.7	<1.0	<.5	<1.0
DSL.C	--	200506805	<2.5	15	<1.0	<.5	<1.0
DSL.4 0–5	2004	200503908	<2.5	E1.0	E1.0	<.5	<1.0
DSL.4 30–35	1999	200503908	<2.5	E.9	E.8	<.5	<1.0
DSL.4 50–55	1995	200503908	<2.5	E1.1	<1.0	<.5	<1.0
DSL.4 80–85	1988	200503908	<2.5	E1.3	E1.2	<.5	<1.0
DSL.4 80–85 lab dup	1988	200503908	<2.5	1.5	E.8	<.5	<1.0
DSL.4 99–104	1984	200503908	<25	<15	<10	<5.0	<10
DSL.4 107–111	1982	200506805	2.9	5.8	<1.0	<.5	<1.0
DSL.4 130–132	1977	200504607	E1.4	2.9	<1.0	<.5	<1.0
DSL.4 136–141	1976	200504607	<2.5	4.2	<1.0	<.5	<1.0
DSL.4 136–-141 lab dup	1976	200504607	<2.5	3.8	<1.0	<.5	E.9
DSL.5 51–58	1987	200504607	E1.6	2.7	<1.0	<.5	E.6
DSL.5 58–64	1985	200504607	5.6	10.5	6.9	<1.0	<2.0
DSL.5 69–73	1982	200504607	19	**34**	2.7	2.3	<1.0
DSL.6 45–51	--	200504607	E1.0	3.5	3.4	<.5	<1.0
Sediment-quality guidelines							
Threshold effect concentration (TEC)	--	none	4.88	3.16	4.16	1.9	2.47
Probable effect concentration (PEC)	--	none	28.0	31.3	62.9	61.8	16.0
Quality assurance samples							
Lab blank	--	200503908	<2.5	<1.5	<1	<.5	<1.5
Lab spike, in percent recovered (acceptable range)	--	200503908	nr	nr	nr	nr	nr
Lab blank	--	200504607	nr	nr	nr	nr	nr
Lab spike, in percent recovered (acceptable range)	--	200504607	70 (22–110)	81 (49–121)	102 (37–99)	93 (40–98)	94 (43–88)
Lab blank	--	200506805	<2.5	<1.5	<1	<.5	<1.5
Lab spike, in percent recovered (acceptable range)	--	200506805	84 (22–110)	75 (49–121)	nr (37–99)	64 (40–98)	57 (43–88)

Appendix 1. Analytical results for selected chlorinated hydrocarbon compounds from samples collected October 5, 2004, from Devil's Swamp Lake, Louisiana—Continued.

Sample ID and interval (centimeters), where applicable	Estimated deposition date	Laboratory set number	Hexa-chloro-benzene	PCB Aroclor 1254	PCB Aroclor 1260	PCB Aroclor 1016+1242
DSL.2 30–35	2001	200503908	E2.2	420	200	140
DSL.2 114–116	1984	200503908	E4.9	510	110	290
DSL.2 136–141	1977	200503908	E1.5	310	100	200
DSL.C	--	200506805	1.9	E780	E310	200
DSL.4 0–5	2004	200503908	E2.2	500	160	130
DSL.4 30–35	1999	200503908	E2.4	220	69	70
DSL.4 50–55	1995	200503908	E3.7	220	69	62
DSL.4 80–85	1988	200503908	E2.9	430	140	96
DSL.4 80–85 lab dup	1988	200503908	E3.1	440	130	110
DSL.4 99–104	1984	200503908	<30	E440	E120	E220
DSL.4 107–111	1982	200506805	4.2	400	240	390
DSL.4 130–132	1977	200504607	4.1	628	207	327
DSL.4 136–141	1976	200504607	3.9	935	323	618
DSL.4 136–141 lab dup	1976	200504607	5.0	1,030	333	683
DSL.5 51–58	1987	200504607	4.9	561	181	318
DSL.5 58–64	1985	200504607	E5.2	1790	628	552
DSL.5 69–73	1982	200504607	3.1	E5,760	2,300	E11,900
DSL.6 45–51	--	200504607	E1.9	1,110	246	754
Sediment-quality guidelines						
Threshold effect concentration (TEC)	--	none	--	--	--	--
Probable effect concentration (PEC)	--	none	--	--	--	--
Quality assurance samples						
Lab blank	--	200503908	<3	<5	<5	<5
Lab spike, in percent recovered (acceptable range)	--	200503908	nr	nr	nr	nr
Lab blank	--	200504607	nr	nr	nr	nr
Lab spike, in percent recovered (acceptable range)	--	200504607	67 (29–83)	102 (43–131)	93 (50–122)	90 (29–109)
Lab blank	--	200506805	<3	<5	<5	<5
Lab spike, in percent recovered (acceptable range)	--	200506805	65 (29–83)	99 (43–131)	87 (50–122)	84 (29–109)

Appendix 1. Analytical results for selected chlorinated hydrocarbon compounds from samples collected October 5, 2004, from Devil's Swamp Lake, Louisiana—Continued.

Sample ID and interval (centimeters), where applicable	Estimated deposition date	Laboratory set number	*cis*-Chlordane	*trans*-Chlordane	*trans*-Nonachlor	PCB 8	PCB 18
DSL.2 30–35	2001	200503908	<1.0	<0.5	<1.0	1.3	2.8
DSL.2 114–116	1984	200503908	<2.0	<1.0	<2.0	2.9	6.5
DSL.2 136–141	1977	200503908	<1.0	1.0	<1.0	1.1	4.4
DSL.C	--	200506805	E.6	E.6	<1.0	E.8	3.1
DSL.4 0–5	2004	200503908	<1.0	<.5	<1.0	1.6	2.5
DSL.4 30–35	1999	200503908	<1.0	<.5	<1.0	1.2	1.4
DSL.4 50–55	1995	200503908	<1.0	<.5	<1.0	1.5	1.2
DSL.4 80–85	1988	200503908	<1.0	<.5	<1.0	E.9	2.0
DSL.4 80–85 lab dup	1988	200503908	<1.0	<.5	<1.0	1.0	3.0
DSL.4 99–104	1984	200503908	<10	<5.0	<10	<10	E6.9
DSL.4 107–111	1982	200506805	<1.0	<.5	<1.0	9.4	11
DSL.4 130–132	1977	200504607	<1.0	E.7	E.9	6.8	7.0
DSL.4 136–141	1976	200504607	<1.0	<.5	<1.0	8.7	46
DSL.4 136–141 lab dup	1976	200504607	<1.0	<.8	<1.0	nr	nr
DSL.5 51–58	1987	200504607	<1.0	<.5	<1.0	7.9	11
DSL.5 58–64	1985	200504607	<2.0	<1.0	<2.0	28	130
DSL.5 69–73	1982	200504607	4.2	3.4	<1.0	300	510
DSL.6 45–51	--	200504607	<1.0	<.50	<1.0	14	67
Sediment-quality guidelines							
Threshold effect concentration (TEC)	--	none	--	--	--	--	--
Probable effect concentration (PEC)	--	none	--	--	--	--	--
Quality assurance samples							
Lab blank	--	200503908	<1	<.5	<1	nr	nr
Lab spike, in percent recovered (acceptable range)	--	200503908	nr	nr	nr	nr	nr
Lab blank	--	200504607	nr	nr	nr	nr	nr
Lab spike, in percent recovered (acceptable range)	--	200504607	102 (43–87)	103 (48–84)	102 (46–90)	nr	nr
Lab blank	--	200506805	<1	<.5	<1	nr	nr
Lab spike, in percent recovered (acceptable range)	--	200506805	59 (43–87)	60 (48–84)	53 (46–90)	nr	nr

Appendix 1. Analytical results for selected chlorinated hydrocarbon compounds from samples collected October 5, 2004, from Devil's Swamp Lake, Louisiana—Continued.

Sample ID and interval (centimeters), where applicable	Estimated deposition date	Laboratory set number	PCB 22	PCB 26	PCB 28	PCB 31	PCB 33	PCB 44
DSL.2 30–35	2001	200503908	2.1	9.7	11	5.9	5.0	8.5
DSL.2 114–116	1984	200503908	4.4	42	39	12	9.4	15
DSL.2 136–141	1977	200503908	3.0	40	22	15	6.3	20
DSL.C	--	200506805	3.2	5.6	18	10	7.9	25
DSL.4 0–5	2004	200503908	1.8	11	8.5	6.4	2.7	7.5
DSL.4 30–35	1999	200503908	E.8	3.9	5.3	3.9	2.6	4.4
DSL.4 50–55	1995	200503908	1.3	2.4	5.7	3.7	3.3	4.0
DSL.4 80–85	1988	200503908	1.1	10	10	5.2	2.6	9.3
DSL.4 80–85 lab dup	1988	200503908	1.9	14	17	8.2	2.7	12
DSL.4 99–104	1984	200503908	<10	E55	E28	E16	E8.7	E22
DSL.4 107–111	1982	200506805	7.5	E63	40	30	15	35
DSL.4 130–132	1977	200504607	4.9	64	41	9.5	4.3	17
DSL.4 136–141	1976	200504607	8.7	96	77	57	7.0	39
DSL.4 136–141 lab dup	1976	200504607	nr	nr	nr	nr	nr	nr
DSL.5 51–58	1987	200504607	5.7	6.6	15	14	9.1	15
DSL.5 58–64	1985	200504607	22	180	140	130	18	75
DSL.5 69–73	1982	200504607	350	E1,000	E900	E610	280	E690
DSL.6 45–51	--	200504607	14	13	94	76	19	36
Sediment-quality guidelines								
Threshold effect concentration (TEC)	--	none	--	--	--	--	--	--
Probable effect concentration (PEC)	--	none	--	--	--	--	--	--
Quality assurance samples								
Lab blank	--	200503908	nr	nr	nr	nr	nr	nr
Lab spike, in percent recovered (acceptable range)	--	200503908	nr	nr	nr	nr	nr	nr
Lab blank	--	200504607	nr	nr	nr	nr	nr	nr
Lab spike, in percent recovered (acceptable range)	--	200504607	nr	nr	nr	nr	nr	nr
Lab blank	--	200506805	nr	nr	nr	nr	nr	nr
Lab spike, in percent recovered (acceptable range)	--	200506805	nr	nr	nr	nr	nr	nr

Appendix 1. Analytical results for selected chlorinated hydrocarbon compounds from samples collected October 5, 2004, from Devil's Swamp Lake, Louisiana—Continued.

Sample ID and interval (centimeters), where applicable	Estimated deposition date	Laboratory set number	PCB 49	PCB 52	PCB 70	PCB 95	PCB 101	PCB 110	PCB 118	PCB 138
DSL.2 30–35	2001	200503908	30	21	16	50	32	44	48	38
DSL.2 114–116	1984	200503908	69	32	22	74	34	50	61	33
DSL.2 136–141	1977	200503908	E96	47	7.3	31	15	38	25	26
DSL.C	--	200506805	E55	E52	E55	E120	E90	E120	E110	E110
DSL.4 0–5	2004	200503908	22	17	19	49	32	47	58	48
DSL.4 30–35	1999	200503908	14	9.0	9.4	28	16	22	24	16
DSL.4 50–55	1995	200503908	14	10	13	32	18	18	25	13
DSL.4 80–85	1988	200503908	24	18	23	59	34	38	48	36
DSL.4 80–85 lab dup	1988	200503908	39	22	24	61	34	43	50	35
DSL.4 99–104	1984	200503908	E84	E46	E11	E63	E29	E50	E49	E39
DSL.4 107–111	1982	200506805	E120	E76	18	68	48	E61	48	42
DSL.4 130–132	1977	200504607	69	61	41	86	44	69	61	56
DSL.4 136–141	1976	200504607	140	99	70	130	65	100	83	84
DSL.4 136–141 lab dup	1976	200504607	nr	nr	nr	nr	nr	nr	nr	nr
DSL.5 51–58	1987	200504607	78	58	68	120	60	63	64	49
DSL.5 58–64	1985	200504607	200	220	200	310	160	230	190	180
DSL.5 69–73	1982	200504607	E1,400	E980	240	E690	270	E810	320	E510
DSL.6 45–51	--	200504607	120	110	130	190	110	120	100	36
Sediment-quality guidelines										
Threshold effect concentration (TEC)	--	none	--	--	--	--	--	--	--	--
Probable effect concentration (PEC)	--	none	--	--	--	--	--	--	--	--
Quality assurance samples										
Lab blank	--	200503908	nr	nr	nr	nr	nr	nr	nr	nr
Lab spike, in percent recovered (acceptable range)	--	200503908	nr	nr	nr	nr	nr	nr	nr	nr
Lab blank	--	200504607	nr	nr	nr	nr	nr	nr	nr	nr
Lab spike, in percent recovered (acceptable range)	--	200504607	nr	nr	nr	nr	nr	nr	nr	nr
Lab blank	--	200506805	nr	nr	nr	nr	nr	nr	nr	nr
Lab spike, in percent recovered (acceptable range)	--	200506805	nr	nr	nr	nr	nr	nr	nr	nr

Appendix 1. Analytical results for selected chlorinated hydrocarbon compounds from samples collected October 5, 2004, from Devil's Swamp Lake, Louisiana—Continued.

Sample ID and interval (centimeters), where applicable	Estimated deposition date	Laboratory set number	PCB 146	PCB 149	PCB 151	PCB 170	PCB 174	PCB 177	PCB 180	PCB 183
DSL.2 30–35	2001	200503908	7.8	31	7.1	11	8.8	5.8	19	4.9
DSL.2 114–116	1984	200503908	6.5	24	5.7	6.2	5.3	3.9	11	3.2
DSL.2 136–141	1977	200503908	5.8	19	3.6	5.2	3.4	3.2	8.6	2.2
DSL.C	--	200506805	19	E54	17	18	12	9.2	27	8.0
DSL.4 0–5	2004	200503908	6.8	24	6.0	9.5	6.8	4.5	15	4.1
DSL.4 30–35	1999	200503908	3.2	12	2.1	3.8	2.6	2.0	6.4	1.7
DSL.4 50–55	1995	200503908	3.8	13	2.9	4.3	2.7	2.4	7.6	2.0
DSL.4 80–85	1988	200503908	6.6	24	5.5	7.8	6.3	4.3	13	4.0
DSL.4 80–85 lab dup	1988	200503908	7.1	23	5.5	2.4	6.4	4.3	12	4.0
DSL.4 99–104	1984	200503908	E8.8	E25	<10	E8.5	E5.0	<10	E13	<10
DSL.4 107–111	1982	200506805	10	40	14	12	10	6.9	19	6.2
DSL.4 130–132	1977	200504607	8.6	41	7.8	7.5	7.0	5.8	9.8	3.5
DSL.4 136–141	1976	200504607	11	70	11	10	9.5	7.6	38	2.9
DSL.4 136–141 lab dup	1976	200504607	nr	nr	nr	nr	nr	nr	nr	nr
DSL.5 51–58	1987	200504607	8.8	53	8.7	8.4	7.6	6.1	12	5.6
DSL.5 58–64	1985	200504607	41	160	23	24	23	17	34	17
DSL.5 69–73	1982	200504607	160	E530	200	140	130	120	200	77
DSL.6 45–51	--	200504607	13	82	12	13	11	7.9	18	7.3
Sediment-quality guidelines										
Threshold effect concentration (TEC)	--	none	--	--	--	--	--	--	--	--
Probable effect concentration (PEC)	--	none	--	--	--	--	--	--	--	--
Quality assurance samples										
Lab blank	--	200503908	nr	nr	nr	nr	nr	nr	nr	nr
Lab spike, in percent recovered (acceptable range)	--	200503908	nr	nr	nr	nr	nr	nr	nr	nr
Lab blank	--	200504607	nr	nr	nr	nr	nr	nr	nr	nr
Lab spike, in percent recovered (acceptable range)	--	200504607	nr	nr	nr	nr	nr	nr	nr	nr
Lab blank	--	200506805	nr	nr	nr	nr	nr	nr	nr	nr
Lab spike, in percent recovered (acceptable range)	--	200506805	nr	nr	nr	nr	nr	nr	nr	nr

Appendix 1. Analytical results for selected chlorinated hydrocarbon compounds from samples collected October 5, 2004, from Devil's Swamp Lake, Louisiana—Continued.

Sample ID and interval (centimeters), where applicable	Estimated deposition date	Laboratory set number	PCB 187	PCB 194	PCB 206	Calculated values		
						Total DDT	ΣPCB_C	ΣPCB_A
DSL.2 30–35	2001	200503908	11	4.1	E1.0	E1.8	E440	**760**
DSL.2 114–116	1984	200503908	6.4	2.1	E.8	E1.5	E580	**910**
DSL.2 136–141	1977	200503908	6.5	2.1	E.7	E3.0	E460	610
DSL.C	--	200506805	15	4.8	1.3	E15	**E970**	**E1,300**
DSL.4 0–5	2004	200503908	7.2	2.8	E.7	E2.0	E420	**790**
DSL.4 30–35	1999	200503908	3.4	1.3	<1.0	E1.8	E200	360
DSL.4 50–55	1995	200503908	4.2	1.5	<1.0	E1.1	E210	350
DSL.4 80–85	1988	200503908	7.1	2.4	E.6	E2.5	E400	**670**
DSL.4 80–85 lab dup	1988	200503908	7.2	2.3	E.7	E2.3	E440	**680**
DSL.4 99–104	1984	200503908	E8.5	<10	<10	<50	E580	**E780**
DSL.4 107–111	1982	200506805	13	4.3	1.3	E8.7	**E830**	**1,000**
DSL.4 130–132	1977	200504607	8.3	3.9	1.4	E4.3	**750**	**1,200**
DSL.4 136–141	1976	200504607	11	5.8	2.3	E4.2	**1,300**	**1,900**
DSL.4 136–141 lab dup	1976	200504607	nr	nr	nr	E3.8	**--**	**2,000**
DSL.5 51–58	1987	200504607	9.0	4.0	E1.0	E4.3	**E770**	**1,100**
DSL.5 58–64	1985	200504607	26	12	3.3	23	**2,800**	**3,000**
DSL.5 69–73	1982	200504607	190	84	28	56	**E12,000**	**E20,000**
DSL.6 45–51	--	200504607	12	5.0	E.5	E7.9	**E1,400**	**2,100**
Sediment-quality guidelines								
Threshold effect concentration (TEC)	--	none	--	--	--	5.28	59.8	59.8
Probable effect concentration (PEC)	--	none	--	--	--	572	676	676
Quality assurance samples								
Lab blank	--	200503908	nr	nr	nr	--	--	--
Lab spike, in percent recovered (acceptable range)	--	200503908	nr	nr	nr	--	--	--
Lab blank	--	200504607	nr	nr	nr	--	--	--
Lab spike, in percent recovered (acceptable range)	--	200504607	nr	nr	nr	--	--	--
Lab blank	--	200506805	nr	nr	nr	--	--	--
Lab spike, in percent recovered (acceptable range)	--	200506805	nr	nr	nr	--	--	--

Appendix 1. Analytical results for selected chlorinated hydrocarbon compounds from samples collected October 5, 2004, from Devil's Swamp Lake, Louisiana—Continued.

Sample ID and interval (centimeters), where applicable	Estimated deposition date	Laboratory set number	Surrogates, in percent recovered (acceptable recovery limits)			Sample mass (grams)
			Isodrin (42-94)	alpha-HCH-d6 (19-125)	Nonachloro-biphenyl (21-140)	
DSL.2 30–35	2001	200503908	84	70	82	13.7
DSL.2 114–116	1984	200503908	82	63	84	12.4
DSL.2 136–141	1977	200503908	77	72	72	16.8
DSL.C	--	200506805	77	61	79	20.7
DSL.4 0–5	2004	200503908	77	72	72	16.8
DSL.4 30–35	1999	200503908	80	72	73	17.4
DSL.4 50–55	1995	200503908	82	67	93	15.7
DSL.4 80–85	1988	200503908	78	67	87	16.0
DSL.4 80–85 lab dup	1988	200503908	77	70	82	15.7
DSL.4 99–104	1984	200503908	78	66	48	15.0
DSL.4 107–111	1982	200506805	69	63	78	13.8
DSL.4 130–132	1977	200504607	111	63	68	15.6
DSL.4 136–141	1976	200504607	nr	81	76	16.9
DSL.4 136–141 lab dup	1976	200504607	nr	87	79	16.9
DSL.5 51–58	1987	200504607	82	82	69	15.5
DSL.5 58–64	1985	200504607	89	89	71	8.7
DSL.5 69–73	1982	200504607	nr	60	118	14.2
DSL.6 45–51	--	200504607	76	75	66	14.3
Sediment-quality guidelines						
Threshold effect concentration (TEC)	--	none	--	--	--	--
Probable effect concentration (PEC)	--	none	--	--	--	--
Quality assurance samples						
Lab blank	--	200503908	80	57	87	25.0
Lab spike, in percent recovered (acceptable range)	--	200503908	nr	nr	nr	25.0
Lab blank	--	200504607	nr	nr	nr	25.0
Lab spike, in percent recovered (acceptable range)	--	200504607	72	70	83	25.0
Lab blank	--	200506805	70	54	84	25.0
Lab spike, in percent recovered (acceptable range)	--	200506805	70	55	82	25.0

Appendix 2—Analytical Results for Polycyclic Aromatic Hydrocarbons

Blank Page

Appendix 2. Analytical results for polycyclic aromatic hydrocarbons from samples collected October 5, 2004, from Devil's Swamp Lake, Louisiana.

[In micrograms per kilogram except as indicated. Concentration in bold exceeds probable effect concentration (MacDonald and others, 2000). ID, identifier; <, nondetection at indicated value; E, estimated value; --, not calculated; lab, laboratory; na, not analyzed; nr, not reported; ΣPAH_{SQG}, sum of selected polycyclic aromatic hydrocarbons (PAHs) used for probable effect concentration; PAH 2+3/comb ratio, sum of 2- and 3-ringed PAHs plus homolog divided by sum of 4- and 5- ringed parent PAHs]

Sample ID and interval (centimeters), where applicable	Estimated deposition date	Laboratory set number	Naphtha-lene	C1-128 Isomers, methylated naphthalenes	2-Ethyl-naphthalene	2,6-Dimethyl-naphthalene	1,6-Dimethyl-naphtha-lene
DSL.2 30–35	2001	200503907	<18	E160	<18	150	21
DSL.2 114–116	1984	200503907	<20	E78	<20	160	27
DSL.2 136–141	1977	200503907	<15	E40	<15	41	<15
DSL.C	--	200506806	<12	<12	<12	<12	<12
DSL.4 0–5	2004	200503907	<16	E65	<16	63	<16
DSL.4 30–35	1999	200503907	<14	E66	<14	51	<14
DSL.4 50–55	1995	200503907	<16	E70	<16	45	<16
DSL.4 80–85	1988	200503907	<16	E69	<16	120	19
DSL.4 99–104	1984	200503907	E7.4	38	<19	30	<19
DSL.4 107–111	1982	200506806	<18	E6.6	<18	100	42
DSL.4 130–132	1977	200504608	E13	E140	E15	76	18
DSL.4 136–141	1976	200504608	<15	E220	24	90	23
DSL.5 58–64	1985	200504608	<29	E1,000	150	270	120
DSL.5 69–73	1982	200504608	54	E1,400	320	740	430
DSL.6 45–51	--	200504608	<17	E260	<17	88	27
Sediment-quality guidelines							
Threshold effect concentration (TEC)	--	none	176	--	--	--	--
Probable effect concentration (PEC)	--	none	561	--	--	--	--
Quality assurance samples							
Lab blank	--	200503907	<10	na	<10	<10	<10
Lab spike, in percent recovered (acceptable range)	--	200503907	68.7 (49–94)	na	69.0 (36–92)	70.3 (33–94)	69.4 (37–89)
Lab blank	--	200504608	nr	na	nr	nr	nr
Lab spike, in percent recovered (acceptable range)	--	200504608	61.1 (49–94)	na	63.8 (36–92)	63.5 (33–94)	65.0 (37-89)
Lab blank	--	200506807	<10	na	<10	<10	<10
Lab spike, in percent recovered (acceptable range)	--	200506807	73.3 (49–94)	na	66.4 (36–92)	63.8 (33–94)	66.9 (37–89)

Appendix 2. Analytical results for polycyclic aromatic hydrocarbons from samples collected October 5, 2004, from Devil's Swamp Lake, Louisiana—Continued.

Sample ID and interval (centimeters), where applicable	Estimated deposition date	Laboratory set number	C2-128 Isomers, C2-alkyated naphthalenes	Acenaph-thylene	1,2-Dimethyl-naphtha-lene	Acenaph-thene	C3-128 Isomers, C3-alkylated naphthalenes
DSL.2 30–35	2001	200503907	E220	69	<18	<18	<55
DSL.2 114–116	1984	200503907	E230	37	<20	<20	E86
DSL.2 136–141	1977	200503907	E80	43	<15	E14	E55
DSL.C	--	200506806	<12	40	<12	<12	<12
DSL.4 0–5	2004	200503907	E100	40	<16	<16	E45
DSL.4 30–35	1999	200503907	E85	27	<14	<14	<40
DSL.4 50–55	1995	200503907	E90	28	<16	E14	E50
DSL.4 80–85	1988	200503907	E170	34	<16	<16	<50
DSL.4 99–104	1984	200503907	78	42	<19	E13	88
DSL.4 107–111	1982	200506806	E19	110	<18	32	E12
DSL.4 130–132	1977	200504608	E180	180	<16	18	E200
DSL.4 136–141	1976	200504608	E220	260	<15	24	E190
DSL.5 58–64	1985	200504608	E1,500	1,600	56	220	E2,200
DSL.5 69–73	1982	200504608	E4,000	1,400	140	410	E6,900
DSL.6 45–51	--	200504608	E270	290	<17	31	<270
Sediment-quality guidelines							
Threshold effect concentration (TEC)	--	none	--	--	--	--	--
Probable effect concentration (PEC)	--	none	--	--	--	--	--
Quality assurance samples							
Lab blank	--	200503907	na	<10	<10	<10	na
Lab spike, in percent recovered (acceptable range)	--	200503907	na	69.8 (33–84)	69.3 (44–89)	71.1 (49–81)	na
Lab blank	--	200504608	na	nr	nr	nr	na
Lab spike, in percent recovered (acceptable range)	--	200504608	na	67.2 (33–84)	65.3 (44–89)	70.9 (49–81)	na
Lab blank	--	200506807	na	<10	<10	<10	na
Lab spike, in percent recovered (acceptable range)	--	200506807	na	71.3 (33–84)	73.1 (44–89)	72.9 (49–81)	na

Appendix 2. Analytical results for polycyclic aromatic hydrocarbons from samples collected October 5, 2004, from Devil's Swamp Lake, Louisiana—Continued.

Sample ID and interval (centimeters), where applicable	Estimated deposition date	Laboratory set number	2,3,6-Trimethyl-naphthalene	9H-Fluorene	C4-128 Isomers, C4-alkylated naphthalenes	1-Methyl-9H-fluorene	Phenan-threne
DSL.2 30–35	2001	200503907	<18	<18	<40	<18	26
DSL.2 114–116	1984	200503907	<20	<20	<50	<20	28
DSL.2 136–141	1977	200503907	<15	<15	<45	<15	24
DSL.C	--	200506806	<12	<12	<12	<12	13
DSL.4 0–5	2004	200503907	<16	<16	<30	<16	19
DSL.4 30–35	1999	200503907	<14	<14	<30	<14	20
DSL.4 50–55	1995	200503907	<16	<16	<40	<16	25
DSL.4 80–85	1988	200503907	<16	<16	<30	<16	E16
DSL.4 99–104	1984	200503907	<19	<19	<60	<19	28
DSL.4 107–111	1982	200506806	<18	45	E8.1	<18	39
DSL.4 130–132	1977	200504608	20	25	E160	<16	68
DSL.4 136–141	1976	200504608	18	33	<110	<15	76
DSL.5 58–64	1985	200504608	100	200	E920	470	270
DSL.5 69–73	1982	200504608	420	**860**	E3,500	1,100	**2,400**
DSL.6 45–51	--	200504608	29	40	<150	<17	120
Sediment-quality guidelines							
Threshold effect concentration (TEC)	--	none	--	77.4	--	--	204
Probable effect concentration (PEC)	--	none	--	536	--	--	1,170
Quality assurance samples							
Lab blank	--	200503907	<10	<10	na	<10	<10
Lab spike, in percent recovered (acceptable range)	--	200503907	69.6 (38–95)	71.0 (31–96)	na	71.3 (37–97)	73.9 (52–90)
Lab blank	--	200504608	nr	nr	na	nr	nr
Lab spike, in percent recovered (acceptable range)	--	200504608	69.6 (38–95)	72.3 (31–96)	na	78.2 (37–97)	81.6 (52–90)
Lab blank	--	200506807	<10	<10	na	<10	<10
Lab spike, in percent recovered (acceptable range)	--	200506807	71.4 (38–95)	71.6 (31–96)	na	74.9 (37–97)	76.4 (52–90)

Appendix 2. Analytical results for polycyclic aromatic hydrocarbons from samples collected October 5, 2004, from Devil's Swamp Lake, Louisiana—Continued.

Sample ID and interval (centimeters), where applicable	Estimated deposition date	Laboratory set number	Anthracene	C5-128 Isomers, C5-alkylated naphthalenes	2-Methylanthracene	4,5-Methylene-phenanthrene	C1-178 Isomers, methylated phenanthrene/anthracenes
DSL.2 30–35	2001	200503907	48	<18	<18	<18	E75
DSL.2 114–116	1984	200503907	29	<20	<20	<20	<70
DSL.2 136–141	1977	200503907	40	<15	<15	18	E47
DSL.C	--	200506806	27	<12	<12	<12	<12
DSL.4 0–5	2004	200503907	25	<16	<16	<16	E56
DSL.4 30–35	1999	200503907	21	<14	<14	<14	E48
DSL.4 50–55	1995	200503907	22	<16	<16	<16	E52
DSL.4 80–85	1988	200503907	21	<16	<16	<16	E44
DSL.4 99–104	1984	200503907	25	<20	<19	E12	50
DSL.4 107–111	1982	200506806	62	<18	<18	26	E9.7
DSL.4 130–132	1977	200504608	98	<45	<16	22	E150
DSL.4 136–141	1976	200504608	130	<35	30	34	E120
DSL.5 58–64	1985	200504608	**1,300**	<170	300	1,100	E1,900
DSL.5 69–73	1982	200504608	**1,700**	E440	440	1,400	E5,900
DSL.6 45–51	--	200504608	200	<45	54	73	E300
Sediment-quality guidelines							
Threshold effect concentration (TEC)	--	none	57.2	--	--	--	--
Probable effect concentration (PEC)	--	none	845	--	--	--	--
Quality assurance samples							
Lab blank	--	200503907	<10	na	<10	<10	na
Lab spike, in percent recovered (acceptable range)	--	200503907	69.5 (44–77)	na	70.7 (27–93)	74.2 (53–90)	na
Lab blank	--	200504608	nr	na	nr	nr	na
Lab spike, in percent recovered (acceptable range)	--	200504608	76.0 (44–77)	na	78.3 (27–93)	82.0 (53–90)	na
Lab blank	--	200506807	<10	na	<10	<10	na
Lab spike, in percent recovered (acceptable range)	--	200506807	72.4 (44–77)	na	72.6 (27–93)	78.9 (53–90)	na

Appendix 2. Analytical results for polycyclic aromatic hydrocarbons from samples collected October 5, 2004, from Devil's Swamp Lake, Louisiana—Continued.

Sample ID and interval (centimeters), where applicable	Estimated deposition date	Laboratory set number	1-Methyl-phenanthrene	C2-178 Isomers, C2-alkylated phenanthrene/ anthracenes	Fluoranthene	Pyrene	C3-178 Isomers, C3-alkylated phenanthrene/ anthracenes
DSL.2 30–35	2001	200503907	<18	E61	37	55	E63
DSL.2 114–116	1984	200503907	<20	<70	30	40	<40
DSL.2 136–141	1977	200503907	<15	E52	72	69	E47
DSL.C	--	200506806	<12	<12	16	17	<12
DSL.4 0–5	2004	200503907	<16	E47	29	41	E46
DSL.4 30–35	1999	200503907	<14	E50	25	35	E40
DSL.4 50–55	1995	200503907	<16	E56	27	38	<45
DSL.4 80–85	1988	200503907	<16	E41	21	28	<40
DSL.4 99–104	1984	200503907	<19	69	34	38	24
DSL.4 107–111	1982	200506806	26	E9.8	50	69	E9.4
DSL.4 130–132	1977	200504608	<16	E200	82	110	E150
DSL.4 136–141	1976	200504608	<15	E110	69	130	E100
DSL.5 58–64	1985	200504608	880	E1,000	1,900	**2,800**	E680
DSL.5 69–73	1982	200504608	1,200	E6,600	1,800	**2,600**	E5,500
DSL.6 45–51	--	200504608	56	E390	170	340	E460
Sediment-quality guidelines							
Threshold effect concentration (TEC)	--	none	--	--	423	195	--
Probable effect concentration (PEC)	--	none	--	--	2,230	1,520	--
Quality assurance samples							
Lab blank	--	200503907	<10	na	<10	<10	na
Lab spike, in percent recovered (acceptable range)	--	200503907	75.1 (57–87)	na	75.0 (65–92)	73.4 (64–94)	na
Lab blank	--	200504608	nr	na	nr	nr	na
Lab spike, in percent recovered (acceptable range)	--	200504608	85.8 (57–87)	na	84.4 (65–92)	84.8 (64–94)	na
Lab blank	--	200506807	<10	na	<10	<10	na
Lab spike, in percent recovered (acceptable range)	--	200506807	77.5 (57–87)	na	78.9 (65–92)	78.8 (64–94)	na

Appendix 2. Analytical results for polycyclic aromatic hydrocarbons from samples collected October 5, 2004, from Devil's Swamp Lake, Louisiana—Continued.

Sample ID and interval (centimeters), where applicable	Estimated deposition date	Laboratory set number	C4-178 Isomers, C4-alkylated phenanthrene/ anthracenes	1-Methyl-pyrene	C1-202 Isomers, methylated fluoranthene/ pyrenes	C2-202 Isomers, C2-alkylated fluoranthene/ pyrenes	C5-178 Isomers, C5-alkylated phenanthrene/ anthracenes
DSL.2 30–35	2001	200503907	<40	<18	E110	E120	<40
DSL.2 114–116	1984	200503907	<30	<20	E74	E84	<30
DSL.2 136–141	1977	200503907	<30	<15	E82	<80	<20
DSL.C	--	200506806	<12	<12	<12	<12	<12
DSL.4 0–5	2004	200503907	<25	<16	E78	E72	<25
DSL.4 30–35	1999	200503907	<20	<14	E66	E77	<30
DSL.4 50–55	1995	200503907	<30	<16	E76	E88	<30
DSL.4 80–85	1988	200503907	<25	<16	E60	<65	<25
DSL.4 99–104	1984	200503907	<19	E12	76	41	<19
DSL.4 107–111	1982	200506806	<18	39	E15	E16	<18
DSL.4 130–132	1977	200504608	E120	40	E190	E280	<35
DSL.4 136–141	1976	200504608	E100	44	E230	E250	<45
DSL.5 58–64	1985	200504608	E380	470	E2,900	E1,400	<150
DSL.5 69–73	1982	200504608	E2,300	1,200	E6,800	E6,300	<210
DSL.6 45–51	--	200504608	E350	120	E660	E820	<50
Sediment-quality guidelines							
Threshold effect concentration (TEC)	--	none	--	--	--	--	--
Probable effect concentration (PEC)	--	none	--	--	--	--	--
Quality assurance samples							
Lab blank	--	200503907	na	<10	na	na	na
Lab spike, in percent recovered (acceptable range)	--	200503907	na	73.4 (57-103)	na	na	na
Lab blank	--	200504608	na	nr	na	na	na
Lab spike, in percent recovered (acceptable range)	--	200504608	na	83.0 (57–103)	na	na	na
Lab blank	--	200506807	na	<10	na	na	na
Lab spike, in percent recovered (acceptable range)	--	200506807	na	78.1 (57–103)	na	na	na

Appendix 2. Analytical results for polycyclic aromatic hydrocarbons from samples collected October 5, 2004, from Devil's Swamp Lake, Louisiana—Continued.

Sample ID and interval (centimeters), where applicable	Estimated deposition date	Laboratory set number	Benz(*a*)-anthracene	Chrysene	C3-202 Isomers, C3-alkylated fluoranthene/pyrenes	C1-228 Isomers, methylated benzo(*a*)-anthracene chrysenes
DSL.2 30–35	2001	200503907	51	60	<80	<100
DSL.2 114–116	1984	200503907	41	40	<60	<70
DSL.2 136–141	1977	200503907	32	37	<50	<50
DSL.C	--	200506806	<12	<12	<12	<12
DSL.4 0–5	2004	200503907	39	44	<50	<80
DSL.4 30–35	1999	200503907	39	45	<50	<80
DSL.4 50–55	1995	200503907	42	47	<55	<80
DSL.4 80–85	1988	200503907	28	31	<50	<50
DSL.4 99–104	1984	200503907	34	28	<40	<70
DSL.4 107–111	1982	200506806	40	62	<18	<18
DSL.4 130–132	1977	200504608	60	80	<160	<170
DSL.4 136–141	1976	200504608	57	73	<120	<140
DSL.5 58–64	1985	200504608	570	700	<490	<720
DSL.5 69–73	1982	200504608	850	**1,700**	E2,700	<3,400
DSL.6 45–51	--	200504608	130	230	<410	<440
Sediment-quality guidelines						
Threshold effect concentration (TEC)	--	none	108	166	- -	- -
Probable effect concentration (PEC)	--	none	1,050	1,290	- -	- -
Quality assurance samples						
Lab blank	--	200503907	<10	<10	na	na
Lab spike, in percent recovered (acceptable range)	--	200503907	73.2 (40–115)	73.7 (61–94)	na	na
Lab blank	--	200504608	nr	nr	na	na
Lab spike, in percent recovered (acceptable range)	--	200504608	87.9 (40–115)	86.9 (61–94)	na	na
Lab blank	--	200506807	<10	<10	na	na
Lab spike, in percent recovered (acceptable range)	--	200506807	70.8 (40–115)	69.1 (61–94)	na	na

Appendix 2. Analytical results for polycyclic aromatic hydrocarbons from samples collected October 5, 2004, from Devil's Swamp Lake, Louisiana—Continued.

Sample ID and interval (centimeters), where applicable	Estimated deposition date	Laboratory set number	C4-202 Isomers, C4-alkylated fluoranthene/ pyrenes	C5-202 Isomers, C5-alkylated fluoranthene/ pyrenes	C2-228 Isomers, C2-alkylated benzo(*a*)-anthracene/ chrysenes	Benzo(*b*)-fluoranthene	Benzo(*k*)-fluoranthene
DSL.2 30–35	2001	200503907	<60	<50	<90	40	47
DSL.2 114–116	1984	200503907	<50	<50	<60	<20	<20
DSL.2 136–141	1977	200503907	<40	<30	<40	25	34
DSL.C	--	200506806	<12	<12	<12	<12	<12
DSL.4 0–5	2004	200503907	<45	<40	<60	31	35
DSL.4 30–35	1999	200503907	<40	<40	<60	<14	<14
DSL.4 50–55	1995	200503907	<50	<50	<60	32	37
DSL.4 80–85	1988	200503907	<40	<30	<50	<16	<16
DSL.4 99–104	1984	200503907	<30	<25	<55	E31	E8.7
DSL.4 107–111	1982	200506806	<18	<18	<18	<18	<18
DSL.4 130–132	1977	200504608	<70	<50	<160	62	33
DSL.4 136–141	1976	200504608	<60	<55	<130	45	52
DSL.5 58–64	1985	200504608	<190	<120	<460	260	270
DSL.5 69–73	1982	200504608	E1,100	<540	<4,000	370	350
DSL.6 45–51	--	200504608	<190	<80	<440	81	73
Sediment-quality guidelines							
Threshold effect concentration (TEC)	--	none	--	--	--	--	--
Probable effect concentration (PEC)	--	none	--	--	--	--	--
Quality assurance samples							
Lab blank	--	200503907	na	na	na	<10	<10
Lab spike, in percent recovered (acceptable range)	--	200503907	na	na	na	74.6 (49–104)	70.1 (40–101)
Lab blank	--	200504608	na	na	na	nr	nr
Lab spike, in percent recovered (acceptable range)	--	200504608	na	na	na	88.9 (49–104)	82.0 (40–101)
Lab blank	--	200506807	na	na	na	<10	<10
Lab spike, in percent recovered (acceptable range)	--	200506807	na	na	na	64.7 (49–104)	62.3 (40–101)

Appendix 2. Analytical results for polycyclic aromatic hydrocarbons from samples collected October 5, 2004, from Devil's Swamp Lake, Louisiana—Continued.

Sample ID and interval (centimeters), where applicable	Estimated deposition date	Laboratory set number	Benzo(*e*)-pyrene	Benzo(*a*)-pyrene	Perylene	C1-252 Isomers, C1-methylated benzopyrene/ perylenes	C3-228 Isomers, C3-benzo(*a*)-anthracene/ chrysenes
DSL.2 30–35	2001	200503907	62	67	210	E170	<80
DSL.2 114–116	1984	200503907	50	59	120	E120	<70
DSL.2 136–141	1977	200503907	34	37	44	<85	<50
DSL.C	--	200506806	<12	<12	<12	<12	<12
DSL.4 0–5	2004	200503907	48	55	99	<130	<50
DSL.4 30–35	1999	200503907	50	54	260	E140	<55
DSL.4 50–55	1995	200503907	51	56	330	E160	<60
DSL.4 80–85	1988	200503907	37	44	200	<100	<45
DSL.4 99–104	1984	200503907	36	35	100	84	<45
DSL.4 107–111	1982	200506806	51	58	150	<18	<18
DSL.4 130–132	1977	200504608	60	71	66	E170	<120
DSL.4 136–141	1976	200504608	73	84	100	E180	<120
DSL.5 58–64	1985	200504608	350	490	240	E700	<370
DSL.5 69–73	1982	200504608	570	670	250	E1,700	<2,700
DSL.6 45–51	--	200504608	110	130	330	E310	<380
Sediment-quality guidelines							
Threshold effect concentration (TEC)	--	none	--	150	--	--	--
Probable effect concentration (PEC)	--	none	--	1,450	--	--	--
Quality assurance samples							
Lab blank	--	200503907	<10	<10	<10	na	na
Lab spike, in percent recovered (acceptable range)	--	200503907	72.7 (35–81)	68.0 (26–101)	68.2 (53–94)	na	na
Lab blank	--	200504608	nr	nr	nr	na	na
Lab spike, in percent recovered (acceptable range)	--	200504608	83.3 (35–81)	80.2 (26–101)	80.7 (53–94)	na	na
Lab blank	--	200506807	<10	<10	<10	na	na
Lab spike, in percent recovered (acceptable range)	--	200506807	63.1 (35–81)	58.4 (26–101)	60.0 (53–94)	na	na

Appendix 2. Analytical results for polycyclic aromatic hydrocarbons from samples collected October 5, 2004, from Devil's Swamp Lake, Louisiana—Continued.

Sample ID and interval (centimeters), where applicable	Estimated deposition date	Laboratory set number	C2-252 Isomers, C2-alkylated benzo-pyrene/ perylenes	C4-228 Isomers, C4-benzo(a)-anthracene/ chrysenes	Benzo (*g,h,i*)-perylene	Indeno-(1,2,3-*c,d*)-pyrene	Dibenzo (*a,h*)-anthracene
DSL.2 30–35	2001	200503907	<130	<60	75	<18	<18
DSL.2 114–116	1984	200503907	<90	<70	<20	<20	<20
DSL.2 136–141	1977	200503907	<50	<30	<15	<15	<15
DSL.C	--	200506806	<12	<12	<12	<12	<12
DSL.4 0–5	2004	200503907	<90	<60	<16	<16	<16
DSL.4 30–35	1999	200503907	<90	<55	54	<14	<14
DSL.4 50–55	1995	200503907	<95	<60	62	<16	<16
DSL.4 80–85	1988	200503907	<70	<40	44	<16	<16
DSL.4 99–104	1984	200503907	<70	<45	39	<19	<19
DSL.4 107–111	1982	200506806	<18	<18	54	26	<18
DSL.4 130–132	1977	200504608	<120	<55	59	47	36
DSL.4 136–141	1976	200504608	<140	<70	69	<15	<15
DSL.5 58–64	1985	200504608	<350	<140	250	210	110
DSL.5 69–73	1982	200504608	E900	<170	250	<18	<18
DSL.6 45–51	--	200504608	<230	<70	78	<17	<17
Sediment-quality guidelines							
Threshold effect concentration (TEC)	--	none	--	--	--	--	33
Probable effect concentration (PEC)	--	none	--	--	--	--	nr
Quality assurance samples							
Lab blank	--	200503907	na	na	<10	<10	<10
Lab spike, in percent recovered (acceptable range)	--	200503907	na	na	69.7 (37–100)	68.7 (31–107)	67.6 (21–123)
Lab blank	--	200504608	na	na	nr	nr	nr
Lab spike, in percent recovered (acceptable range)	--	200504608	na	na	85.9 (37–100)	82.8 (31–107)	81.6 (21–123)
Lab blank	--	200506807	na	na	<10	<10	<10
Lab spike, in percent recovered (acceptable range)	--	200506807	na	na	62.0 (37–100)	66.5 (31–107)	65.8 (21–123)

Appendix 2. Analytical results for polycyclic aromatic hydrocarbons from samples collected October 5, 2004, from Devil's Swamp Lake, Louisiana—Continued.

Sample ID and interval (centimeters), where applicable	Estimated deposition date	Laboratory set number	C3-252 Isomers, C3-alkylated benzopyrene/ perylenes	C4-252 Isomers, C4-alkylated benzopyrene/ perylenes	C5-228 Isomers, C5-benzo(*a*)-anthracene/ chrysenes	C5-252 Isomers, C5-alkylated benzopyrene/ perylenes
DSL.2 30–35	2001	200503907	<100	<80	<100	<75
DSL.2 114–116	1984	200503907	<80	<60	<100	<70
DSL.2 136–141	1977	200503907	<55	<40	<40	<45
DSL.C	--	200506806	<12	<12	<12	<12
DSL.4 0–5	2004	200503907	<70	<60	<90	<60
DSL.4 30–35	1999	200503907	<70	<50	<80	<60
DSL.4 50–55	1995	200503907	<90	<55	<90	<70
DSL.4 80–85	1988	200503907	<65	<50	<65	<55
DSL.4 99–104	1984	200503907	<45	<30	<55	<35
DSL.4 107–111	1982	200506806	<18	<18	<18	<18
DSL.4 130–132	1977	200504608	<120	<60	<65	<65
DSL.4 136–141	1976	200504608	<120	<75	<80	<65
DSL.5 58–64	1985	200504608	<270	<150	<140	<170
DSL.5 69–73	1982	200504608	<940	<470	<290	<120
DSL.6 45–51	--	200504608	<210	<130	<80	<75
Sediment-quality guidelines						
Threshold effect concentration (TEC)	--	none	--	--	--	--
Probable effect concentration (PEC)	--	none	--	--	--	--
Quality assurance samples						
Lab blank	--	200503907	na	na	na	na
Lab spike, in percent recovered (acceptable range)	--	200503907	na	na	na	na
Lab blank	--	200504608	na	na	na	na
Lab spike, in percent recovered (acceptable range)	--	200504608	na	na	na	na
Lab blank	--	200506807	na	na	na	na
Lab spike, in percent recovered (acceptable range)	--	200506807	na	na	na	na

Appendix 2. Analytical results for polycyclic aromatic hydrocarbons from samples collected October 5, 2004, from Devil's Swamp Lake, Louisiana—Continued.

Sample ID and interval (centimeters), where applicable	Estimated deposition date	Laboratory set number	Calculated values		Surrogates, in percent recovered (acceptable recovery limits)			Sample mass (grams)
			ΣPAH_{SQG}	PAH 2+3/ comb ratio	2-Fluoro-biphenyl (46-88)	Nitrobenzene-d5 (46-88)	p-Terphenyl-d14 (46-88)	
DSL.2 30–35	2001	200503907	570	1.2	55	44	71	13.7
DSL.2 114–116	1984	200503907	380	1.5	55	50	61	12.4
DSL.2 136–141	1977	200503907	410	.98	62	58	75	16.8
DSL.C	--	200506806	110	.83	65	83	63	20.7
DSL.4 0–5	2004	200503907	360	1.1	58	52	62	15.4
DSL.4 30–35	1999	200503907	330	.96	61	63	70	17.4
DSL.4 50–55	1995	200503907	370	.85	62	55	67	15.7
DSL.4 80–85	1988	200503907	290	1.5	57	53	61	16.0
DSL.4 99–104	1984	200503907	320	.16	66	78	69	15.0
DSL.4 107–111	1982	200506806	570	.28	64	84	56	13.8
DSL.4 130–132	1977	200504608	980	2.0	49	42	57	15.6
DSL.4 136–141	1976	200504608	1,100	1.6	57	59	69	16.9
DSL.5 58–64	1985	200504608	11,000	1.2	58	54	71	8.7
DSL.5 69–73	1982	200504608	16,000	4.0	69	76	102	14.2
DSL.6 45–51	--	200504608	2,000	1.5	67	59	73	14.3
Sediment-quality guidelines								
Threshold effect concentration (TEC)	--	none	1,610	--	--	--	--	--
Probable effect concentration (PEC)	--	none	22,800	--	--	--	--	--
Quality assurance samples								
Lab blank	--	200503907	--	--	59	55	65	25.0
Lab spike, in percent recovered (acceptable range)	--	200503907	--	--	67	60	69	25.0
Lab blank	--	200504608	--	--	nr	nr	nr	nr
Lab spike, in percent recovered (acceptable range)	--	200504608	--	--	59	59	81	25.0
Lab blank	--	200506807	--	--	47	56	94	25.0
Lab spike, in percent recovered (acceptable range)	--	200506807	--	--	68	56	74	25.0

Appendix 3—Analytical Results for Major and Trace Elements

Appendix 3. Analytical results for major and trace elements from samples collected October 5, 2004, from Devil's Swamp Lake, Louisiana.

[In micrograms per gram except as indicated. Concentration in bold exceeds probable effect concentration (MacDonald and others, 2000). ID, identifier; --, not calculated; SRMs, standard reference materials; nr, not reported; <, nondetection at indicated value]

Sample ID and interval (centimeters), where applicable	Estimated deposition date	Total carbon (percent)	Inorganic carbon (percent)	Organic carbon (percent)	Aluminum	Calcium	Iron	Potassium
DSL.2 30–35	2001	1.35	0.02	1.33	87,600	5,240	40,100	15,700
DSL.2 114–116	1984	.74	.03	.71	86,400	4,460	39,600	15,600
DSL.2 136–141	1977	.41	.04	.37	73,500	4,510	30,700	15,000
DSL.C	--	.81	.03	.78	43,900	5,180	27,200	13,300
DSL.4 0–5	2004	1.38	.01	1.37	63,800	4,260	25,600	14,200
DSL.4 30–35	1999	1.13	.01	1.12	70,400	4,580	30,600	15,900
DSL.4 50–55	1995	.95	.02	.93	76,600	4,210	32,600	14,900
DSL.4 80–85	1988	.85	.03	.82	73,800	4,140	35,200	15,800
DSL.4 99–104	1984	.50	.08	.42	67,400	4,320	30,100	14,600
DSL.4 107–111	1982	.68	.02	.66	62,400	3,830	27,400	14,300
DSL.4 130–132	1977	.56	.02	.54	59,400	3,790	23,500	14,600
DSL.4 136–141	1976	.80	.04	.76	66,200	4,150	29,800	14,800
DSL.5 51–58	1987	1.53	.02	1.51	78,600	4,160	37,100	15,800
DSL.5 58–64	1985	2.39	.02	2.37	87,600	4,530	47,700	16,000
DSL.5 69–73	1982	2.39	.01	2.38	87,100	4,010	41,600	13,900
DSL.6 45–51	--	2.25	.01	2.24	78,400	5,160	36,400	17,200
Sediment-quality guidelines								
Threshold effect concentration (TEC)	--	--	--	--	--	--	--	--
Probable effect concentration (PEC)	--	--	--	--	--	--	--	--
Quality assurance samples (SRMs)								
PACS-2 found		nr	nr	nr	65,250	20,000	41,550	12,400
PACS-2 true		nr	nr	nr	66,200	19,600	40,900	12,400
Relative percent difference		--	--	--	1.4	2.0	1.6	0
MESS-1 found		nr	nr	nr	57,700	5,050	31,700	19,000
MESS-1 true[1]		nr	nr	nr	58,400	4,820	30,490	18,600
Relative percent difference		--	--	--	1.2	4.7	3.9	2.1
LKSD-1 found		nr	nr	nr	41,750	77,200	28,500	9,315
LKSD-1 true[1]		nr	nr	nr	41,300	77,200	28,700	9,460
Relative percent difference		--	--	--	1.1	0	.7	1.5
MAG-1 found		nr	nr	nr	84,700	10,100	49,900	30,400
MAG-1 true[1]		nr	nr	nr	86,660	9,790	47,600	29,500
Relative percent difference		--	--	--	2.3	3.1	4.7	3.0

Footnote at end of table.

Appendix 3. Analytical results for major and trace elements from samples collected October 5, 2004, from Devil's Swamp Lake, Louisiana—Continued.

Sample ID and interval (centimeters), where applicable	Estimated deposition date	Magnesium	Sodium	Phosphorus	Titanium	Arsenic	Barium	Beryllium
DSL.2 30–35	2001	7,290	4,070	1,110	4,260	12.7	612	2.1
DSL.2 114–116	1984	7,030	8,310	854	4,480	15.3	564	2.1
DSL.2 136–141	1977	5,780	7,760	780	4,150	10.1	546	1.8
DSL.C	--	3,520	5,960	694	3,090	12.4	710	1.9
DSL.4 0–5	2004	4,800	5,720	830	3,850	12.6	563	1.5
DSL.4 30–35	1999	5,810	6,040	922	4,350	10.2	598	1.8
DSL.4 50–55	1995	5,990	5,730	912	4,010	10.4	555	1.8
DSL.4 80–85	1988	6,440	7,010	1,390	3,900	11.7	573	1.8
DSL.4 99–104	1984	5,330	7,170	873	3,790	8.2	529	1.7
DSL.4 107–111	1982	5,070	7,060	995	3,830	9.0	546	1.5
DSL.4 130–132	1977	4,720	7,440	742	3,630	9.6	560	1.6
DSL.4 136–141	1976	5,610	7,020	1,090	3,980	11.4	592	1.7
DSL.5 51–58	1987	6,670	5,660	1,290	4,710	17.2	657	2.1
DSL.5 58–64	1985	7,780	5,500	1,560	4,710	23.2	992	2.5
DSL.5 69–73	1982	6,270	5,790	932	4,110	18.9	695	2.0
DSL.6 45–51	--	7,130	5,620	1,610	4,140	17.6	763	2.2
Sediment-quality guidelines								
Threshold effect concentration (TEC)	--	--	--	--	--	9.79	--	--
Probable effect concentration (PEC)	--	--	--	--	--	33	--	--
Quality assurance samples (SRMs)								
PACS-2 found		14,850	34,600	1,013	4,675	26.9	925	1.2
PACS-2 true		14,700	34,500	960	4,430	26.2	nr	1.0
Relative percent difference		1.0	.3	5.4	5.4	2.6	--	18.2
MESS-1 found		9,020	18,200	705	4,210	11.0	308	2.4
MESS-1 true[1]		8,690	18,500	637	5,430	10.6	nr	1.9
Relative percent difference		3.7	1.6	10.1	25.3	3.7	--	23.3
LKSD-1 found		10,500	14,800	751	2,885	35.9	414	.86
LKSD-1 true[1]		10,400	14,800	698	3,180	40.0	430	1.1
Relative percent difference		1.0	0	7.2	9.7	10.8	3.8	24.5
MAG-1 found		18,700	28,400	726	4,380	10.1	502	3.2
MAG-1 true[1]		18,090	28,400	711	4,500	9.2	479	3.2
Relative percent difference		3.3	0	2.1	2.7	9.3	4.7	0

Footnote at end of table.

Appendix 3. Analytical results for major and trace elements from samples collected October 5, 2004, from Devil's Swamp Lake, Louisiana—Continued.

Sample ID and interval (centimeters), where applicable	Estimated deposition date	Cadmium	Cobalt	Chromium	Copper	Mercury	Lithium	Manganese
DSL.2 30–35	2001	1.9	12.9	84.3	29.4	0.11	43.8	965
DSL.2 114–116	1984	**6.0**	13.3	86.4	38.5	.66	45.2	461
DSL.2 136–141	1977	2.6	11.5	69.4	35.3	.65	37.5	273
DSL.C	--	.32	16.6	46.7	19.3	.08	23.3	1,000
DSL.4 0–5	2004	**5.3**	10.7	58.7	23.2	.08	29.0	454
DSL.4 30–35	1999	**6.6**	12.4	66.4	25.1	.08	35.1	575
DSL.4 50–55	1995	4.0	11.5	66.1	25.6	.12	35.4	734
DSL.4 80–85	1988	3.9	11.9	74.6	33.3	1.0	38.5	839
DSL.4 99–104	1984	3.1	9.8	64.0	29.4	.45	33.4	697
DSL.4 107–111	1982	**5.8**	10.7	72.6	29.9	**1.3**	33.2	487
DSL.4 130–132	1977	4.3	15.2	56.2	49.0	.86	28.6	413
DSL.4 136–141	1976	**7.4**	12.1	79.5	70.7	.98	32.4	685
DSL.5 51–58	1987	**19.1**	15.7	91.9	63.0	.62	43.9	771
DSL.5 58–64	1985	**20.8**	19.0	**135**	44.0	.16	50.9	850
DSL.5 69–73	1982	**9.5**	32.1	92.8	57.0	.15	42.2	517
DSL.6 45–51	--	**11.9**	15.7	90.4	33.0	.11	40.8	844
Sediment-quality guidelines								
Threshold effect concentration (TEC)	--	.99	--	43.4	31.6	.18	--	--
Probable effect concentration (PEC)	--	4.98	--	111	149	1.06	--	--
Quality assurance samples (SRMs)								
PACS-2 found		2.3	11.8	88.4	300	nr	30.7	440
PACS-2 true		2.1	11.5	90.7	310	nr	32.2	440
Relative percent difference		8.6	2.6	2.6	3.4	--	4.8	.1
MESS-1 found		.7	12.1	58.2	28.2	nr	43.9	522
MESS-1 true[1]		.6	10.8	71.0	25.1	nr	44.9	512
Relative percent difference		14.2	11.4	19.8	11.6	--	2.3	1.9
LKSD-1 found		1.4	10.5	28.3	43.6	nr	6.5	688
LKSD-1 true[1]		nr	11.0	31.0	44.0	nr	7.0	697
Relative percent difference		--	5.1	9.1	.9	--	8.2	1.4
MAG-1 found		.2	22.4	106	30.7	nr	79.3	777
MAG-1 true[1]		.2	20.4	97.0	30.0	nr	79.0	760
Relative percent difference		3.9	9.3	8.9	2.3	--	.4	2.2

Footnote at end of table.

Appendix 3. Analytical results for major and trace elements from samples collected October 5, 2004, from Devil's Swamp Lake, Louisiana—Continued.

Sample ID and interval (centimeters), where applicable	Estimated deposition date	Nickel	Lead	Scandium	Strontium	Vanadium	Zinc	Antimony
DSL.2 30–35	2001	36.8	48.3	14.0	86.7	118	134	2.6
DSL.2 114–116	1984	36.9	74.2	14.2	87.1	118	170	7.2
DSL.2 136–141	1977	33.4	37.9	11.7	87.7	96.0	149	5.5
DSL.C	--	25.8	30.7	7.4	89.8	83.4	79.9	.97
DSL.4 0–5	2004	26.1	77.6	9.8	87.4	81.5	107	3.9
DSL.4 30–35	1999	28.6	62.6	11.4	91.2	94.2	122	3.6
DSL.4 50–55	1995	28.7	48.2	12.0	80.5	96.3	112	3.1
DSL.4 80–85	1988	30.5	54.7	12.4	86.1	103	143	12.0
DSL.4 99–104	1984	28.3	40.4	10.6	88.4	92.4	136	3.9
DSL.4 107–111	1982	28.4	54.4	9.9	85.2	86.0	135	5.5
DSL.4 130–132	1977	35.0	78.6	9.0	88.8	75.4	158	3.0
DSL.4 136–141	1976	40.2	78.0	10.7	91.0	95.0	161	4.1
DSL.5 51–58	1987	**52.1**	**134**	13.4	83.7	116	196	8.1
DSL.5 58–64	1985	**128**	**176**	15.4	84.6	144	234	13.9
DSL.5 69–73	1982	**158**	**223**	13.9	78.4	110	371	11.3
DSL.6 45–51	--	**78.1**	121	13.0	109	125	171	10.7
Sediment-quality guidelines								
Threshold effect concentration (TEC)	--	22.7	35.8	--	--	--	121	--
Probable effect concentration (PEC)	--	48.6	128	--	--	--	459	--
Quality assurance samples (SRMs)								
PACS-2 found		37.7	176	14.7	278	135	367	11.4
PACS-2 true		39.5	183	nr	276	133	364	11.3
Relative percent difference		4.7	3.9	--	.7	1.5	.8	.9
MESS-1 found		27.3	34.8	10.9	88.3	76.2	191	.73
MESS-1 true[1]		29.5	34.0	nr	nr	72.4	191	.73
Relative percent difference		7.7	2.3	--	--	5.1	0	0
LKSD-1 found		16.0	89.1	8.3	268	49.4	327	.98
LKSD-1 true[1]		16.0	82.0	9.0	250	50.0	331	1.2
Relative percent difference		.3	8.3	8.7	6.8	1.2	1.4	20.2
MAG-1 found		49.2	28.1	18.6	143	143	137	.94
MAG-1 true[1]		53.0	24.0	17.2	146	140	130	.96
Relative percent difference		7.4	15.7	7.8	2.1	2.1	5.2	2.1

Footnote at end of table.

Appendix 3. Analytical results for major and trace elements from samples collected October 5, 2004, from Devil's Swamp Lake, Louisiana—Continued.

Sample ID and interval (centimeters), where applicable	Estimated deposition date	Bismuth	Cerium	Cesium	Gallium	Lanthanum	Molybdenum	Rubidium	Niobium
DSL.2 30–35	2001	0.30	77.9	7.3	19.0	42.0	1.3	96.2	21
DSL.2 114–116	1984	.35	80.1	26.4	19.2	46.0	9.9	97.3	23
DSL.2 136–141	1977	.42	69.5	18.4	16.1	40.3	3.1	83.3	21
DSL.C	--	.21	88.0	3.1	10.7	32.5	1.4	59.8	11
DSL.4 0–5	2004	.22	69.0	4.2	13.6	36.8	.93	73.8	18
DSL.4 30–35	1999	.24	73.4	5.0	15.8	39.7	1.0	84.9	21
DSL.4 50–55	1995	.27	68.7	8.6	16.1	38.3	1.1	84.2	18
DSL.4 80–85	1988	.30	70.0	25.2	17.0	39.7	3.0	91.0	19
DSL.4 99–104	1984	.36	66.7	14.7	14.6	36.8	2.0	77.1	16
DSL.4 107–111	1982	.37	62.6	11.1	14.6	34.6	2.2	75.6	16
DSL.4 130–132	1977	.58	59.8	4.5	13.4	34.2	1.5	71.7	16
DSL.4 136–141	1976	.35	67.9	4.6	15.9	37.1	1.4	81.5	18
DSL.5 51–58	1987	.36	80.0	5.6	18.7	43.6	2.3	95.4	21
DSL.5 58–64	1985	.36	83.8	6.6	21.1	45.7	5.0	103	25
DSL.5 69–73	1982	.29	76.1	5.4	18.4	44.6	12.3	89.8	21
DSL.6 45–51	--	.30	81.3	5.8	17.9	42.2	2.2	97.9	20
Sediment-quality guidelines									
Threshold effect concentration (TEC)	--	--	--	--	--	--	--	--	--
Probable effect concentration (PEC)	--	--	--	--	--	--	--	--	--
Quality assurance samples (SRMs)									
PACS-2 found		.34	32.0	2.1	13.6	16.0	5.3	42.0	11.0
PACS-2 true		nr	nr	nr	nr	nr	5.4	nr	nr
Relative percent difference		--	--	--	--	--	3.4	--	--
MESS-1 found		.33	74.4	4.2	13.5	39	2.3	94.7	17.0
MESS-1 true[1]		nr	nr	nr	nr	nr	nr	nr	nr
Relative percent difference		--	--	--	--	--	--	--	--
LKSD-1 found		.87	26.6	.69	8.8	15.2	9.6	23.0	4.4
LKSD-1 true[1]		nr	27.0	nr	nr	16.0	10.0	24.0	nr
Relative percent difference		--	1.5	--	--	5.5	4.1	4.5	--
MAG-1 found		.36	86.5	8.4	22.3	43.4	1.1	154	22.0
MAG-1 true[1]		.34	88.0	8.6	20.4	43.0	1.6	149	12.0
Relative percent difference		5.7	1.7	2.4	8.9	.9	37.0	3.3	58.8

Footnote at end of table.

Appendix 3. Analytical results for major and trace elements from samples collected October 5, 2004, from Devil's Swamp Lake, Louisiana—Continued.

Sample ID and interval (centimeters), where applicable	Estimated deposition date	Silver	Tantalum	Thallium	Thorium	Uranium	Yttrium
DSL.2 30–35	2001	<2	4.2	1.00	12.6	3.34	29.1
DSL.2 114–116	1984	2.6	3.6	2.22	12.8	2.92	31.3
DSL.2 136–141	1977	<2	3.0	1.35	11.6	2.74	26.8
DSL.C	--	<2	.31	.52	9.46	2.29	23.0
DSL.4 0–5	2004	<2	2.4	.80	10.6	2.76	25.9
DSL.4 30–35	1999	<2	2.7	.95	11.6	3.04	30.6
DSL.4 50–55	1995	<2	.95	.94	11.5	2.88	27.3
DSL.4 80–85	1988	2.1	1.2	3.34	11.7	2.88	27.0
DSL.4 99–104	1984	<2	.81	.96	10.8	2.67	25.8
DSL.4 107–111	1982	<2	.83	1.51	10.6	2.72	24.2
DSL.4 130–132	1977	<2	.68	1.55	10.4	2.46	23.3
DSL.4 136–141	1976	<2	.93	.92	11.0	2.73	25.9
DSL.5 51–58	1987	<2	1.4	1.26	12.4	3.10	30.7
DSL.5 58–64	1985	<2	7.2	1.92	13.2	3.35	32.2
DSL.5 69–73	1982	<2	4.9	1.92	12.4	2.96	32.4
DSL.6 45–51	--	<2	1.4	1.62	12.3	3.29	29.3
Sediment-quality guidelines							
Threshold effect concentration (TEC)	--	--	--	--	--	--	--
Probable effect concentration (PEC)	--	--	--	--	--	--	--
Quality assurance samples (SRMs)							
PACS-2 found		<2	.34	.62	4.19	2.44	17.4
PACS-2 true		1.2	nr	.60	nr	nr	nr
Relative percent difference		--	--	2.5	--	--	--
MESS-1 found		<2	1.2	.65	12.8	3.65	25.5
MESS-1 true[1]		nr	nr	nr	nr	nr	nr
Relative percent difference		--	--	--	--	--	--
LKSD-1 found		<2	nr	.35	2.05	9.61	21.9
LKSD-1 true[1]		.6	.30	nr	2.20	9.70	19.0
Relative percent difference		--	--	--	7.3	1.0	14.0
MAG-1 found		<2	1.9	.76	12.60	2.81	24.6
MAG-1 true[1]		.1	1.1	nr	11.9	2.70	28.0
Relative percent difference		--	52.5	--	5.7	4.0	12.9

[1] True concentrations in SRM samples from Potts and others (1992).

Prepared by the USGS Texas Water Science Center:
8027 Exchange Drive
Austin, TX 78754–4733

Information regarding water resources in Texas is available at
http: //tx.usgs.gov/